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# CHILD DEVELOPMENT

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# FELS MENTAL AGE VALUES FOR GESELL SCHEDULES

VIRGINIA NELSON AND T. W. RICHARDS[1]

One of the tests most widely used at the infant level is the Gesell Schedules (3). Gesell presents no device for standardization of total score, much less mental age. In our work here at Fels we have found it useful in graphing progress of the individual child to use mental age where possible, and the standard score method for other variables. Since the Gesell Schedules are not standardized in terms of mental age, it was impossible to plot the child's score in these terms without developing norms of such type. The present report presents the tentative mental age norms we developed for our own use, on the supposition that such norms for the Gesell Schedules might be useful elsewhere.

Children were tested[2] at half-yearly intervals by means of the Gesell Schedules at 6, 12, 18, and 24 months, the Merrill-Palmer Scale at 24, 30, 36, 42, 48, and 54 months, and the Stanford-Binet at 36, 48, and 60 months. Since the Fels study is a longitudinal one, the group studied is, or will be, composed of the same children at each age level. Obviously the group becomes smaller with the increase in age, since the total group of children is spread over a period of from the fetal stage to ten years. Test results used for obtaining distributions of mental age were used only when the child was tested within a restricted period about his birthday; this period was arbitrarily set at one per cent of the total age of the child (including 280 prenatal days).

In Table 1 are presented for each age level the mean score and the standard deviation for the Merrill-Palmer and Stanford-Binet Scales, mental age values at the mean, at the mean plus one sigma and the mean minus one sigma of raw score, together with the IQ's which would result from such MA values. It is seen that the mean IQ is about 115, and there is a deviation of about 15 points in IQ to account for the sigma of mental age. If we assume that though individuals may vary longitudinally the characteristics of the group distribution as measured by the Gesell Schedules are similar to those of the distributions as measured by the M-P and S-B scales later on, that is, and that the mean variability and nature of the curve are constant, it seems legitimate to calculate mental age equivalents for the raw score Gesell values (total number of items passed) in the following way:

Let the mean Gesell score represent that mental age which provides an IQ of 115, and let the sigma in mental age for the Gesell Schedules be represented by that difference from the mean in mental age which would provide an IQ of 100 for the score at -1 sigma and 130 for the score at +1 sigma.

When these values were calculated for each of the Gesell Schedules at the age points at which we have used them, the following results were obtained:

[1] *From the Samuel S. Fels Research Institute, Yellow Springs, Ohio.*
[2] *All tests were administered by the senior author.*

| Age Levels | Mean MA | Sigma MA |
|---|---|---|
| 6 months | 6.90 | .9 |
| 12 months | 13.80 | 1.8 |
| 18 months | 20.70 | 2.7 |
| 24 months | 27.60 | 3.6 |

Mental age values for the raw score of the scales at each level may now be calculated according to the following equations:

For six months, 3.9196 + .1076555 x
For twelve months, 4.1662 + .302 x
For eighteen months, 9.492 + .389 x
For twenty-four months, 17.048 + .443 x

These equations are regression equations with an assumed correlation of 1 between age levels.

TABLE 1

AGE GROUPS, MEAN AND DISTRIBUTION SIGMAS OF MENTAL TEST SCORES, WITH MENTAL AGE AND IQ EQUIVALENTS

| Scale | Age in Months | Number Cases | Score | | M. A. Equivalents | | | I. Q. Equivalents | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mean Score | Sigma | Mean | Mean - 1σ | Mean + 1σ | Mean | Mean - 1σ | Mean + 1σ |
| Gesell | 6 | 74 | 27.68 | 8.36 | | | | | | |
| Gesell | 12 | 77 | 31.90 | 5.96 | | | | | | |
| Gesell | 18 | 68 | 28.80 | 6.94 | | | | | | |
| Gesell | 24 | 67 | 23.81 | 8.12 | | | | | | |
| Merrill Palmer | | 71 | 19.39 | 5.07 | 27 | 25 | 30 | 112.5 | 104.2 | 125.0 |
| " | 30 | 64 | 32.62 | 8.34 | 33 | 30 | 37 | 110.0 | 100.0 | 123.3 |
| " | 36 | 62 | 49.55 | 10.32 | 40 | 36 | 47 | 111.1 | 100.0 | 129.2 |
| Stanford Binet | | 66 | 42.36 | 6.08 | 42 | 36 | 49 | 116.7 | 100.0 | 135.0 |
| Merrill Palmer | 42 | 64 | 61.81 | 10.29 | 48 | 42 | 55 | 114.3 | 98.8 | 131.0 |
| " | 48 | 56 | 74.41 | 7.94 | 57 | 51 | 70 | 118.8 | 105.2 | 144.8 |
| Stanford Binet | | 58 | 55.03 | 7.66 | 55 | 47 | 63 | 114.6 | 97.9 | 131.3 |
| Merrill Palmer | 54 | 35 | 80.47 | 7.04 | 65 | 57 | 76 | 119.4 | 104.6 | 139.8 |
| Stanford Binet | 60 | 56 | 67.61 | 8.33 | 68 | 59 | 76 | 112.7 | 98.3 | 126.7 |
| Mean | | | | | | | | 114.5 | 101.0 | 131.2 |

Mental age values for the Schedules at each level are presented in Table 2.

TABLE 2

MENTAL AGE VALUES FOR NUMBER OF GESELL ITEMS PASSED AT FOUR AGE LEVELS

| No. Items Passed | Months | | | | No. Items Passed | Months | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | | 6 | 12 | 18 | 24 |
| 1 | 3.8 | 4.5 | 9.9 | 17.5 | 26 | 6.5 | 12.0 | 19.6 | 28.6 |
| 2 | 3.9 | 4.8 | 10.3 | 17.9 | 27 | 6.5 | 12.3 | 20.0 | 29.0 |
| 3 | 4.0 | 5.1 | 10.7 | 18.4 | 28 | 6.7 | 12.6 | 20.4 | 29.5 |
| 4 | 4.1 | 5.4 | 11.1 | 18.8 | 29 | 6.8 | 12.9 | 20.8 | 29.9 |
| 5 | 4.2 | 5.7 | 11.4 | 19.3 | 30 | 6.9 | 13.2 | 21.2 | 30.3 |
| 6 | 4.4 | 6.0 | 11.8 | 19.7 | 31 | 7.0 | 13.5 | 21.6 | 30.8 |
| 7 | 4.5 | 6.3 | 12.2 | 20.1 | 32 | 7.1 | 13.8 | 21.9 | 31.2 |
| 8 | 4.6 | 6.6 | 12.6 | 20.6 | 33 | 7.3 | 14.1 | 22.3 | 31.7 |
| 9 | 4.7 | 6.9 | 13.0 | 21.0 | 34 | 7.4 | 14.4 | 22.7 | 32.1 |
| 10 | 4.8 | 7.2 | 13.4 | 21.5 | 35 | 7.5 | 14.7 | 23.1 | 32.6 |
| 11 | 4.9 | 7.5 | 13.8 | 21.9 | 36 | 7.6 | 15.0 | 23.5 | 33.0 |
| 12 | 5.0 | 7.8 | 14.2 | 22.4 | 37 | 7.7 | 15.3 | 23.9 | 33.4 |
| 13 | 5.1 | 8.1 | 14.6 | 22.8 | 38 | 7.8 | 15.6 | 24.3 | 33.9 |
| 14 | 5.2 | 8.4 | 14.9 | 23.3 | 39 | 7.9 | 15.9 | 24.7 | 34.3 |
| 15 | 5.3 | 8.7 | 15.3 | 23.7 | 40 | 8.0 | 16.2 | 25.1 | 34.8 |
| 16 | 5.4 | 9.0 | 15.7 | 24.1 | 41 | 8.1 | 16.5 | 25.4 | 35.2 |
| 17 | 5.5 | 9.3 | 16.1 | 24.6 | 42 | 8.2 | 16.9 | 25.8 | 35.7 |
| 18 | 5.6 | 9.6 | 16.5 | 25.0 | 43 | 8.3 | 17.2 | 26.2 | 36.1 |
| 19 | 5.7 | 9.9 | 16.9 | 25.5 | 44 | 8.4 | 17.5 | 26.6 | 36.5 |
| 20 | 5.9 | 10.2 | 17.3 | 25.9 | 45 | 8.5 | 17.8 | 27.0 | |
| 21 | 6.0 | 10.5 | 17.7 | 26.4 | 46 | 8.7 | 18.1 | 27.4 | |
| 22 | 6.1 | 10.8 | 18.1 | 26.8 | 47 | 8.8 | 18.4 | 27.8 | |
| 23 | 6.2 | 11.1 | 18.4 | 27.2 | 48 | 8.9 | 18.7 | 28.2 | |
| 24 | 6.3 | 11.4 | 18.8 | 27.7 | 49 | | 19.0 | 28.6 | |
| 25 | 6.4 | 11.7 | 19.2 | 28.1 | 50 | | | 28.9 | |

## DISCUSSION

The foregoing method of calculating mental age values makes certain assumptions which may be controversial. It assumes 1) that the function "mental ability" is similar at various points during the first five years and 2) that variability in this function is constant over this period.

Opposing the validity of the first assumption is a considerable body of evidence to show that mental tests at various ages during infancy are not highly correlated, and that they predict poorly for later mental status. This evidence merits consideration, for the lack of correlation might suggest lack of "identical elements" between tests at two age levels. From the longitudinal viewpoint, however, it is possible that correlation between two age levels, involving varied environmental forces, may be an expression not so much of "identical elements" as identical imperviousness of the elements forming the test ability to influences in the environment. Length of the body at one point is logically similar to length at a later point, as heart rate may be similar to later heart rate. But a probable higher longitudinal intercorrelation for height than for heart rate would be an expression of the fact that height is less affected by the environment than is heart rate; the degree of

identity of the phenomena is beyond question. Low intercorrelations between mental tests at early age levels may be due in part to the fact that dissimilar functions are measured; it is more likely, however, that the functions measured are similar but that children are more susceptible to deviation in these functions than they are later in life, when such intercorrelations between mental ability at various age levels are higher.

Regarding the second point in question - that is, the assumption of constant group variation in mental ability, contrary evidence of Thurstone (4) is pertinent. Thurstone is convinced that "absolute variability" in mental ability increases with age. It is not clear that this increase in "absolute variability" is an increase over and above what we would expect with a constant coefficient of variability for an increasing chronological age. Since Thurstone's method of calculating absolute variability is considerably unlike the method of calculating variability for the distributions used here, it is difficult to apply his rationale to our own situation. We have been able to check our assumption of constant variability by scoring the Gesell performances at six and at twelve months by means of the age values Bayley (1,2) obtained for certain of the items used by us. Bayley's age placement values for 24 items yielded at six months an age score which for 52 cases, correlated .893 with our raw score, and for 63 cases at twelve months (on twenty items), .735. A comparison of the mean and standard deviations of these age values with these measures for the age values obtained by our inference method follows:

| | | 6 mos | 12 mos. |
|---|---|---|---|
| Mean | Bayley | 7.04 | 14.06 |
| | Fels | 6.90 | 13.80 |
| S. D. | Bayley | 0.96 | 1.49 |
| | Fels | 0.90 | 1.80 |

This evidence would indicate that the values obtained on the basis of what Bayley found were actual age values were not significantly less variable at six months than those obtained when it was assumed that variability was constant over this early period. The difference between the standard deviations divided by the sigma difference was .5. At twelve months the variability obtained by using Bayley's values was less (the difference divided by the sigma of the difference being 1.3).

## SUMMARY

The construction of these tables of mental age values for the Gesell Schedules assumes similarity of function measured by the schedules and by repeated Merrill-Palmer and Stanford-Binet tests later than two years. It also assumes that the coefficient of variability is constant, - that variability increases with increase in mean score.

On the basis of these assumptions, mental age values for Gesell Schedules are presented in Table 2.

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# A STUDY ON THE TREND OF WEIGHT IN WHITE SCHOOL CHILDREN FROM 1933 TO 1936

## MATERIAL BASED ON THE EXAMINATIONS OF PUPILS OF THE ELEMENTARY SCHOOLS IN HAGERSTOWN, MARYLAND

GEORG WOLFF, M.D.[1]

### INTRODUCTION

In several papers Palmer (1,2,3,4) reported the results of investigations on the growth of the white elementary school children of Hagerstown, Maryland, dealing especially with the variations in the weight of the children aged 6 to 11 years during the period 1921-1927 and during some of the years (1933-1934) of the economic depression. Annual observations on the growth, particularly in weight, of the Hagerstown children have been continued by the U. S. Public Health Service so that it is possible to report on the weight of children for the years following 1933 and thus to extend the findings of Palmer. At the same time, in this and in the following series of reports it is hoped that by the comparisons of the results obtained on children of the same ages in different calendar years and on children of different age groups in the same calendar year to arrive at a better understanding of the pattern of growth characteristics of white school children.

The study of growth may be approached in three different ways. First, the results of the measurements may be given for children of the same age at different calendar years. By this method striking environmental influences upon growth may be discovered as, for instance, those that affected children of Central Europe after a short period of especially deficient nutrition during and immediately subsequent to the last World War (5). In addition, the existence of a tendency to increase in size, as has been demonstrated in many parts of the world, can also be described by such comparative measurements when they cover a long succession of years.

Second, the results may be obtained for children of the same generation at successive years of age. This would be the case if we were able to pursue a school generation, let us say, from 6 years of age in 1930 throughout the whole school life until the age of 16 years in 1940. The characteristics of the pattern of growth of the same generations could thus be described when it is assumed that the hereditary and environmental factors for the group as a whole have been almost constant and provided that the number of children does not greatly diminish or change throughout the years of observation (6,7). We could call the resulting pattern the average "individual" or "longitudinal" growth curve for the specified generation (e.g., school generation - 1930, 6 years of age or, correspondingly, birth generation 1923-24) and compare it from many points of view with other generations, former or later ones of the same

[1] *From the Division of Public Health Methods, National Institute of Health, U. S. Public Health Service and the Milbank Memorial Fund.*

*The author is deeply indebted to Doctor Antonio Ciocco for specific suggestions to improve the text and for invaluable criticism during the preparation of the paper.*

place, or with the corresponding generations in other cities, states, nations, races, etc.

This second method of study is usually not applied for want of sufficient consecutive data on a large number of children of the same generation over a relatively long period of time. Therefore, the data are mostly combined from different generations or, in practice, from all the different age classes present in the same calendar year. This is the third method or the most common way of constructing a growth curve for practical purposes. By doing so we assume that the observed differences from age group to age group represent the pattern of growth in the successive ages of the same generation, or the growth curve of the average individual from a given time on. In other words, we do about the same in this case as when constructing a life table.

However, it must not be forgotten that when the life table technique is used the observations dealt with always concern a series of simultaneously living generations. An unforeseen bio-sociological event may change greatly the variables involved as, for instance, in the case of mortality, a sudden pandemic may occur or some deteriorating factor may diminish the general resistance of the population. It will be recalled that in Europe in the first World War in addition to the battle losses, influenza epidemics, tuberculosis and starvation increased enormously the general mortality of the populations involved. The experiences in Europe during and after the war of 1914-1918 similarly indicate that such phenomena can also affect the rhythm of growth of certain generations of children. In Germany and Austria it was shown that those generations of children whose infancy and early childhood coincided with the starvation period of the war and of the immediate post-war period suffered a distinct retardation of growth, in weight as well as in height (Martin (8), Peller (9), Schlesinger (10), Wolff (11)), as compared with former and particularly later generations.

In the investigation of Berlin school children (Wolff) it was especially striking that the children born in the period of serious food shortage in Germany, 1917-1919, still showed six years later - when they entered school and were first systematically measured - a distinct growth deficit in comparison with earlier and, still more, with later generations of school entrants of the same ages. For example, the children who first entered school in 1932 were on the average 6.0 to 6.5 cm. taller and 1.0 to 1.6 kg. heavier than the new admissions of 1924. It will be recalled also that in an investigation on the Viennese population, Peller noted that the births of the late war years 1917-1919 and still in 1920-1922 had significantly inferior body-weight than the births of previous years. These war-time observations which in effect constitute the results of an involuntary mass experiment on under-nutrition of mother and child point to the importance of the environmental influences, probably pre- and post-natal, upon the growth of children. Such results are in good agreement with the experimental findings in mice reported by Agnes Bluhm (12) who could demonstrate the retardation of growth in young mice with low birth weights. From the above observations and animal experiments the same conclusions for man are reached as for other animals, namely; that the intra-uterine growth rate while mainly determined by heredity, nevertheless is also influenced by the environmental factor of maternal

nutrition. Moreover, this factor is apparently also responsible for a further post-foetal retardation still distinct at the end of early childhood. This phenomenon may explain the different "growing" years which, for instance, Palmer (2) found in elementary school children in Hagerstown, or the frequently observed retardation in the growth of school children from economically unfavorable social strata as compared with children from wealthier families. Such a socio-economic growth differential was particularly well shown for the growth of German children in elementary and secondary schools in the careful investigation by Oettinger (13). It seems safe, therefore, to regard such differences as due to environmental rather than to genotypic variations.

In this respect it is well to call attention to still another point about the German post-war experience. The question is often asked: Did the retardations demonstrated in the growth of the school entrants persist, or were the deficits made up in the course of the following eight years of school life which were for the most part of normal nutritional condition? An exact answer could only be given when the entrants of the years 1924-1926 left school eight years later. They are not exactly the same children because of some internal school migration, but they are of the same birth generations. The anthropometric data on school graduates in 1931, 1932 and 1933 - the measurements and computations could not be continued in the subsequent years - showed indeed no retardation in the bodily development. On the contrary these children also exhibited, in comparison with earlier generations of graduates, a general improvement. For instance, in boys 13½ - 14 years old, the increase in height of the graduates of 1933 over those of 1925 amounted to 7.2 ± 0.889 cm., in weight to 4.7 ± 0.862 kg. In girls of the same age the corresponding increases were 5.8 ± 0.870 cm. in height and 3.7 ± 0.875 kg. in weight. The added standard errors of the differences make it plain that the increases both in stature and weight lie beyond the ordinary limits of chance, being in all instances more than three times the standard errors. Therefore, there can be little doubt that the older children, born in the hunger years of the war, compensated for the growth deficit that was still manifest at the age when they entered school in 1924 to 1926. Thus a permanent injury does not seem to have resulted. These observations make it plain that even the marked growth retardations of the war-born generations were only of a transitory character, probably caused by the environmental influences of undernutrition rather than by any genotypic variation.

With these observations in mind the results obtained by the application of the three methods of study described above will be discussed in this and the following papers in which consideration will also be given to the effects of other variables of growth. In this paper, the changes in weight observed from 1933 to 1936 in the white elementary school population will be examined.

## MATERIAL AND METHODS

The methods of measurement are the same as described by Palmer in the above cited papers. The weight has been recorded in pounds while height which has been measured since 1935 was in that year recorded in

inches, and in later years in centimeters. At the weighing the children discarded shoes, vests, sweaters, or coats, but retained the regular indoor clothing. The measurements have been taken each year within the first half of the month of May, the actual day of measuring varying slightly in the successive calendar years.

In the tabulation of the original data five-pound class intervals have been used. Sheppard's corrections for the effect of grouping are not applied. In this material it has been found several times by experimental computations that there is no essential difference in the final results whether the children of the same sample are grouped in five, three, or two-pound classes. Thus, to abbreviate the work of calculation, five-pound intervals have been adopted for the reduction of the actual distributions of weight.

The observational data for the four year period 1933 to 1936 covered in this study concern a total of 14,401 weights taken in successive years: 7,134 on boys and 7,267 on girls. The distribution of the number of children weighed each year may be seen from Table 1 which also gives the age range of the children.

TABLE 1

NUMBER OF BOYS AND GIRLS WEIGHED IN HAGERSTOWN, MD., 1933 TO 1936

| Year | Boys | Girls | Total | Age Range |
|---|---|---|---|---|
| 1933 | 1,499 | 1,493 | 2,992 | 6 - 13 years |
| 1934 | 1,387 | 1,385 | 2,772 | 6 - 14 years |
| 1935 | 2,026 | 2,023 | 4,049 | 6 - 15 years |
| 1936 | 2,222 | 2,366 | 4,588 | 6 - 16 years |
| All years | 7,134 | 7,267 | 14,401 | - |

In each calendar year a new generation, the children aged 6-7 years, enters the observation and each generation advances to a higher age class. Since the investigation started in 1933 with children 6 to 13 years of age, in 1934 the ages including the new school admissions range from 6 to 14, in 1935 from 6 to 15, and in 1936 from 6 to 16 years. However, it must be noted that the children who enter the successive age classes are not always identically the same children although a fairly large proportion of the children first observed at 6, 7, 8 - years have been individually followed through the later school years. Thus, although there is more or less a change in the actual constituents of the different age groups from year to year, nevertheless all individuals included in a specified age group during a certain calendar year represent the same generation regarding birth year.

In any anthropometric study of school children the definition and delimitation of the age of the child at examination must be considered. It often happens that confusion arises with regard to the exact limits of the age group. The children of this investigation are grouped into age classes by single years, the age being taken as of the last birthday before the date of examination assumed to be May 1st. Therefore, the age designation 6, 7, 8 - years has the meaning of completed year of age. For example, the term 6-7 years of age covers the range from exactly 6

years to 6 years and 364 days, the mid-point for the age group thus being 6½ years. This may be illustrated by the following tabulation which regards the 8-year-old girls examined in the spring of 1933 and who were born, of course, in two successive calendar years (238 in 1924 and 96 in 1925, totaling 334). The distribution of the months of birth for this sample is shown in Table 2.

In the above quoted papers on the growth of school children in Hagerstown the age was determined from the birthday nearest January 1 of the school year in which the measurements were taken (1). Since the examination took place four months later (in May), the children were on the average 6, 7, 8 - years + 4 months of age. In the present investigation the children measured in May were actually 6-7, 7-8, 8-9 - or 6½, 7½, 8½ years of age (in the anthropological midpoint term) as shown in the above example. Therefore, for an exact comparison of the former results of Palmer's investigations with the present ones in Hagerstown, it is necessary to add the average increment of two more months in order to adjust the obtained mean weights to each other. The adjustment can be easily done since in Palmer's papers the average yearly increments as well as the average monthly increments for the same ages are given. The somewhat different delimitation of the age classes is also the reason why the numbers of children by age classes in the present paper, for instance for 1933, do not agree perfectly with the former observation.

TABLE 2

MONTH AND YEAR OF BIRTH OF 334 GIRLS, CONSIDERED 8 YEARS OF AGE AT THE TIME OF EXAMINATION ON MAY 1, 1933

| 1924 | | 1925 | |
|---|---|---|---|
| Month | Number of girls | Month | Number of girls |
| May | 36 | January | 18 |
| June | 23 | February | 25 |
| July | 28 | March | 31 |
| August | 29 | April | 22 |
| September | 34 | | |
| October | 22 | | |
| November | 35 | | |
| December | 31 | | |
| Totals | 238 | | 96 |

THE WEIGHT OF THE WHITE HAGERSTOWN SCHOOL CHILDREN 1933 - 1936

The present analysis of the records on the weight of the Hagerstown school children from 1933 to 1936 makes it possible to extend the growth studies begun in the same community during the seven years period, 1921 - 1927. By the comparison covering almost two decades we are further enabled to deal with the question of the general and much discussed tendency of the increase in physical size observed almost all over the civilized world for some fifty years or more (cf. Bowles 16), especially from recruiting statistics and other data on adults.

The cause of this general increase of physical size is supposedly

due to the general improvement of social and economic conditions, sport, physical and hygienic education, and especially better national nutrition. Whatever the causative factors may be, the average increase is considered an established fact. For these reasons it is of public health interest to watch the height and weight constants from year to year for the same population because these may be regarded to some degree as an index of current public health conditions. In addition, it will have also importance as a contribution to the physiology of growth if we are able to follow up the same generation until the end of its growing period.

Having both features in mind, the data on the white Hagerstown school population, boys and girls of the same ages, are presented in the following tabulations. These contain for each age class the number of children examined in each calendar year - of course, not the total of the Hagerstown school population - the range of the weight distribution, the mean weight in pounds and its standard error, the standard deviation and the coefficient of variation.

## BOYS AND GIRLS 6-7 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS

Starting now with the discussion of the single age groups at successive calendar years, and considering first the mean weights of the boys and girls 6-7 years of age (cf. Table 3), it is observed that for both sexes there was a slight decrease in average weight from 1933 through 1936; the lowest weight was found for both sexes in 1935: 46.34 $\pm$ 0.474 pounds for boys and 44.64 $\pm$ 0.470 pounds for girls. Although the differences from year to year lie within the limits of chance fluctuations, as can be seen when the standard errors are added to or subtracted from the respective means, the consistent tendency observed in boys and girls might have some meaning. The largest difference between the mean weights is found between that of 1933 and that of 1935 and it amounts to 1.03 $\pm$ 0.709 pounds for boys and 1.37 $\pm$ 0.748 pounds for girls. This means that for each sex the difference is not quite twice its standard error. Therefore, so long as there is no more significant proof of a real loss of weight in 1935, or of a general decline in growth (as could be demonstrated by observations on stature), it is sufficient to mention that the phenomenon is observed in both sexes.

The tendency to some decrease in the weight for this age group from 1933 to 1936 is still more emphasized when the results for these years are compared with the corresponding mean weight for the combined years 1921 to 1927 as calculated from Palmer's investigations in Hagerstown. After the age class limit has been adjusted as described above by taking into account an increment of two more months, the mean weight for the boys 6-7 years of age in 1921-1927 equals 47.62 $\pm$ 0.345 pounds while for the girls it is 46.56 $\pm$ 0.347 pounds. Therefore, if the corrections applied are acceptable, in recent years there has been a decrease of weight in both boys and girls.

The variability of weight as measured by the standard deviation and the coefficient of variation, respectively, does not vary markedly from year to year. But there is one point worth mentioning, namely; that in most of the years the girls exhibit a somewhat higher variability than

TABLE 3

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 6-7 YEARS OF AGE.

| Year | Boys | | | | | Girls | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Weight | | | | Number | Weight | | | |
| | | Range | Mean ± standard error | Standard deviation | Coefficient of variation | | Range | Mean ± standard error | Standard deviation | Coefficient of variation |
| 1933 | 150 | 35-89 | 47.37 ± .527 | 6.45 | 13.62 | 148 | 30-84 | 46.01 ± .582 | 7.08 | 15.39 |
| 1934 | 75 | 35-59 | 47.23 ± .617 | 5.35 | 11.32 | 81 | 30-74 | 45.65 ± .763 | 6.87 | 15.05 |
| 1935 | 147 | 30-64 | 46.34 ± .474 | 5.75 | 12.40 | 161 | 30-69 | 44.64 ± .470 | 5.97 | 13.37 |
| 1936 | 129 | 30-64 | 46.84 ± .578 | 6.57 | 14.03 | 139 | 30-69 | 44.95 ± .515 | 6.07 | 13.50 |
| 1921-27* | 238 | | 47.62 ± .357 | 5.51 | 11.57 | 237 | | 46.57 ± .357 | 5.49 | 11.79 |

*Mean weight and standard deviation for the combined years 1921-27 are taken from Palmer's former investigations (1-4) and adjusted to the age of the present investigation by arithmetic interpolation of the annual increments for two more months. For example, the calculated mean weight of boys, 6 years of age, was given as 46.83 pounds, the mean annual gain of those boys from 6 to 7 years of age as 4.75 pounds. Thus, for two more months of growth, the weight was increased by two-twelfths of 4.75 pounds or 0.79 pounds, which gives a total of 47.62 pounds. A fairly good estimation of the standard deviation can be obtained by interpolation of the given values at 6 and 7 years of age 5.32 and 6.44 pounds. Two-twelfths of this difference of 1.12 plus 5.32 pounds equals 5.51 pounds as the adjusted standard deviation due to the dispersing effect of growth.

TABLE 4

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 7-8 YEARS OF AGE.

| Year | Boys | | | | | Girls | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Weight | | | | Number | Weight | | | |
| | | Range | Mean ± standard error | Standard deviation | Coefficient of variation | | Range | Mean ± standard error | Standard deviation | Coefficient of variation |
| 1933 | 202 | 35-84 | 50.89 ± .443 | 6.29 | 12.37 | 211 | 30-84 | 49.89 ± .531 | 7.72 | 15.47 |
| 1934 | 176 | 35-74 | 50.60 ± .449 | 5.95 | 11.77 | 176 | 35-99 | 49.80 ± .634 | 8.41 | 16.88 |
| 1935 | 216 | 35-74 | 51.39 ± .435 | 6.39 | 12.44 | 209 | 35-84 | 49.29 ± .497 | 7.19 | 14.58 |
| 1936 | 234 | 35-74 | 50.64 ± .440 | 6.74 | 13.30 | 246 | 30-84 | 48.82 ± .441 | 6.91 | 14.15 |
| 1921-27* | 596 | | 51.56 ± .270 | 6.60 | 12.80 | 573 | | 49.96 ± .270 | 6.46 | 12.93 |

*Compare footnote to Table 3.

the boys as is demonstrated by the relative measure of variability. It may be further worth noticing that the variability constants in both sexes were somewhat larger in the years from 1933 on than in the former period 1921-1927. This result is in agreement with Palmer's findings for the year 1933 alone and would suggest that in the years following 1933, the years associated with the economic depression in the United States, there was some tendency to an increase in the variability of body weight for boys and girls.

BOYS AND GIRLS 7-8 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 4)

For this age group the average weight of boys and girls during the period of the present observation does not show much change nor is there any distinct tendency to decrease. There is perhaps a small decline for girls in 1936, but the fluctuations from year to year lie within the limits of chance as the simple standard errors of the means plainly show. The same is true if we compare the results of the present observation with the adjusted average weights of boys and girls for 1921-1927. Therefore, it seems to be reasonably clear that the average weight of the children 7-8 years of age in Hagerstown has remained fairly constant during the last two decades, taking into account the normal fluctuations of random sampling. It may be mentioned again that in every year of observation the boys exceed in weight the girls by 1 to 2 pounds. This, of course, is beyond the limits of chance and corresponds to the biological pattern of growth with regard to sex differences in childhood.

The variability presents the same feature as for the previous age group; it is at each year distinctly larger in girls than in boys as the values of the standard deviation and coefficient of variation demonstrate. Only in the period 1921-1927 the adjusted standard deviation is somewhat smaller for girls but this is not true for the coefficient of variation. Aside from this there is nothing striking in the variability constants for each year. When compared to the preceding age (6-7 years), the standard deviations of the 7-8 year class rise a little indicating the steadily dispersing effect of growth, again more distinct for girls. In addition, it might be worth mentioning that for girls both measures of variability tend to be greater in all the years since 1933 than in the period 1921-1927 when the standard deviation of 6.46 pounds and the coefficient of variation of 12.93 per cent exhibited the lowest level (see Table 4).

BOYS AND GIRLS 8-9 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 5)

In the four years under observation, from 1933 to 1936, there is no significant change in the mean weight of this age group. Even the greatest differences between 1933 and 1934 for boys, and for girls between 1935 to 1936, are reasonably explained by the laws of chance fluctuation as the values of the standard errors of the respective means indicate. Considering again the adjusted values of the period 1921-1927 there is no doubt that the average weight of the children of this age has been fairly constant within the last two decades. The boys show in each year

of observation a higher body weight than the girls although not as distinct as in the younger age groups. Only in the year 1936 when the weight of the boys increased whereas that of the girls decreased, as compared with the preceding calendar year, the sex difference in weight is significant in the statistical sense and amounts to almost exactly 2 pounds.

The variability of weight, as measured by the standard deviation and the relative parameter of variation, demonstrates again the existence of a wider range of weight fluctuations for girls than boys. But the most striking point in this respect is that the years under observation, in particular 1933, 1934, and 1935, when compared to the period 1921-1927, tend to be associated with a distinctly larger variation in the body weight of the girls. This finding for the years of economic crisis confirms again the former results of Palmer's investigations.

## BOYS AND GIRLS 9-10 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 6)

In this age group the changes in the mean weights from year to year are obviously statistically insignificant. Even when we take the largest difference found in either sex, that for the girls who average in 1933 60.07 $\pm$ 0.694 pounds and 61.78 $\pm$ 0.909 pounds in 1936, the difference amounts to 1.71 $\pm$ 1.144 pounds and is only 1.5 times its standard error. Since all the means and their standard errors are given in the tables, the statistical meaning of the differences can be easily verified. It will be noted that from 1933 to 1936 the trend of the weights in the boys is the reverse of that for the girls: The mean body weight for the boys went down, that of the girls went up. It is impossible at this stage of the investigation to give an explanation for this finding. It could be explained by chance alone or it might be caused by some substantial factors that we do not know as yet. This inverse trend of the boys and girls, 9-10 years of age, is also the reason that only in 1933 and 1934 the mean weights of the boys are distinctly higher than those of the girls. There is almost no more difference in 1935, and in 1936 the girls are even somewhat heavier than the boys of the same age. This greater weight of the girls is not statistically significant yet it is mentioned because it is unique for this age group.

The variability of the distributions exhibits the same trend as demonstrated before. The standard deviations and coefficients of variation are remarkably larger for girls than for boys. And again in comparison with the adjusted data of the former period 1921-1927, the figures clearly indicate that no significant change has occurred for boys, whereas the variability for girls has increased in the period under observation. This finding indicates that weight is more stable for the male school child, and that the recent years of the economic depression were apparently associated with a distinct upward trend in the group variability of body weight in the female sex.

## BOYS AND GIRLS 10-11 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 7)

In this age group, it may be noted that the mean weights of boys

TABLE 5

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 8-9 YEARS OF AGE.

| Year | Boys | | | | | Girls | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Weight | | | | Number | Weight | | | |
| | | Range | Mean ± standard error | Standard deviation | Coefficient of variation | | Range | Mean ± standard error | Standard deviation | Coefficient of variation |
| 1933 | 250 | 35-89 | 56.72 ± .500 | 7.91 | 13.94 | 243 | 35-134 | 55.69 ± .678 | 10.57 | 18.98 |
| 1934 | 202 | 35-99 | 55.37 ± .481 | 6.83 | 12.34 | 208 | 35-109 | 55.02 ± .669 | 9.65 | 17.53 |
| 1935 | 212 | 40-94 | 55.85 ± .479 | 6.98 | 12.49 | 206 | 35-114 | 55.66 ± .708 | 10.17 | 18.27 |
| 1936 | 230 | 40-94 | 56.39 ± .489 | 7.41 | 13.15 | 234 | 35-89 | 54.40 ± .506 | 7.74 | 14.23 |
| 1921-27* | 839 | | 56.94 ± .262 | 7.60 | 13.35 | 811 | | 55.14 ± .274 | 7.80 | 14.15 |

*Adjusted values, compare footnote to Table 3.

TABLE 6

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 9-10 YEARS OF AGE.

| Year | Boys | | | | | Girls | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Weight | | | | Number | Weight | | | |
| | | Range | Mean ± standard error | Standard deviation | Coefficient of variation | | Range | Mean ± standard error | Standard deviation | Coefficient of variation |
| 1933 | 220 | 35-119 | 62.34 ± .626 | 9.29 | 14.90 | 228 | 40-119 | 60.07 ± .694 | 10.48 | 17.44 |
| 1934 | 233 | 40-99 | 61.92 ± .603 | 9.21 | 14.87 | 245 | 40-134 | 60.46 ± .774 | 12.12 | 20.04 |
| 1935 | 215 | 40-119 | 61.04 ± .594 | 8.71 | 14.27 | 222 | 40-124 | 60.90 ± .783 | 11.67 | 19.17 |
| 1936 | 266 | 40-99 | 61.32 ± .501 | 8.17 | 13.32 | 243 | 35-144 | 61.78 ± .909 | 14.17 | 22.94 |
| 1921-27* | 978 | | 62.59 ± .288 | 9.01 | 14.40 | 921 | | 60.63 ± .317 | 9.63 | 15.88 |

*Adjusted values, compare footnote to Table 3.

and girls follow the same inverse trend as observed for the younger group. The average weight for boys, in the present period of observation, diminished from 68.50 ± 0.682 pounds in 1933 to 66.81 ± 0.606 in 1936 with a maximum in 1934, while the average weight for girls increased within the same period from 66.64 ± 0.780 pounds to 68.45 ± 0.924, respectively, with a corresponding minimum in 1934. The differences are considerable. By taking the highest and lowest values for each sex (1934 and 1936) the decrease in boys amounts to 1.84 ± 0.994 pounds, the increase in girls to 2.08 ± 1.327 pounds. Both differences, although amounting to around 2 pounds, are statistically not significant in the strict sense of the probability theory because of the high mean errors. This is especially true in the case of the girls although the difference in their weight exceeds that of the boys. However, the girls have a distinctly higher variability as demonstrated by the standard deviation and the variation coefficient and consequently the standard error is also higher. Keeping this in mind we have to state that also for this age group the difference between the average weights are statistically not significant, probably due to the dispersing effect of growth, especially for girls. On the other hand, we must not overlook the peculiar feature of an inverse trend of average weight for boys and girls in the period of economic depression.

There is not much to be added about the variability of weight in this age group. In girls as has been mentioned above, the tabulated values are greater than those of boys for every calendar year. It is further obvious that as compared with the adjusted values of the former period 1921-1927, only the girls develop, except for the year 1933, distinctly higher values of the variation parameters. Thus it suggests itself that the past years of the economic depression have increased, indeed, the variability of body weight of girls in contrast to the greater stability of weight of boys.

### BOYS AND GIRLS 11-12 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 8)

It is to be seen from the tabulated mean weights and their errors that in this age group there is no consistent difference in the single calendar years from 1933 to 1936. This is especially true for the boys whose average weights are fairly constant; the fluctuations lie within the limits of a single standard error even when compared with the adjusted average of the former period 1921-1927. For girls it is a little different. Excepting the year 1933, there is again a clear tendency to an increase in body weight, from 74.71 ± 1.013 pounds in 1934 to 77.15 ± 1.123 pounds in 1936. It is the same tendency as demonstrated in the preceding age groups, 9-10 and 10-11 years. However, even the difference of 2.44 pounds, considering the high errors of the mean weights, falls within the limits of chance fluctuations. The mean error of the difference equals ± 1.512. So, the observed difference of 2.44 pounds is only 1.61 times its standard error. A ratio of this size would mean that such a deviation could occur by chance alone eleven times out of one hundred trials or once in nine times. Therefore, the observed difference according to the general convention of interpreting the probability curve is statistically not significant. Of course, we must not forget that

TABLE 7

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 10-11 YEARS OF AGE.

| Year | Boys | | | | | Girls | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Weight | | | | Number | Weight | | | |
| | | Range | Mean ± standard error | Standard deviation | Coefficient of variation | | Range | Mean ± standard error | Standard deviation | Coefficient of variation |
| 1933 | 224 | 40-114 | 68.50 ± .682 | 10.21 | 14.90 | 222 | 45-114 | 66.64 ± .780 | 11.62 | 17.44 |
| 1934 | 209 | 45-144 | 68.65 ± .788 | 11.39 | 16.59 | 217 | 40-134 | 66.37 ± .952 | 14.03 | 21.13 |
| 1935 | 254 | 40-129 | 67.97 ± .679 | 10.82 | 15.92 | 247 | 40-154 | 67.97 ± .935 | 14.70 | 21.63 |
| 1936 | 233 | 40-124 | 66.81 ± .606 | 9.25 | 13.85 | 248 | 40-154 | 68.45 ± .924 | 14.56 | 21.27 |
| 1921-27* | 992 | | 68.35 ± .344 | 10.84 | 15.86 | 925 | | 67.49 ± .394 | 11.97 | 17.74 |

*Adjusted values, compare footnote to Table 3.

TABLE 8

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 11-12 YEARS OF AGE.

| Year | Boys | | | | | Girls | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Weight | | | | Number | Weight | | | |
| | | Range | Mean ± standard error | Standard deviation | Coefficient of variation | | Range | Mean ± standard error | Standard deviation | Coefficient of variation |
| 1933 | 225 | 45-139 | 75.43 ± .804 | 12.07 | 16.00 | 242 | 45-144 | 76.51 ± 1.000 | 15.55 | 20.32 |
| 1934 | 220 | 45-129 | 74.80 ± .804 | 11.92 | 15.94 | 229 | 45-154 | 74.71 ± 1.013 | 15.34 | 20.53 |
| 1935 | 246 | 50-154 | 75.24 ± .770 | 12.08 | 16.05 | 231 | 45-159 | 75.53 ± 1.128 | 17.14 | 22.70 |
| 1936 | 259 | 45-139 | 74.55 ± .836 | 13.45 | 18.04 | 269 | 45-184 | 77.15 ± 1.123 | 18.42 | 23.88 |
| 1922-27* | 868 | | 75.22 ± .430 | 12.66 | 16.83 | 798 | | 75.90 ± .524 | 14.79 | 19.49 |

*Adjusted values, compare footnote to Table 3.

these restrictions are nothing more than a statistical convention to exclude as much as possible the action of chance fluctuations. As large a difference as the above considered independently from its computed standard error, may have a thoroughly real meaning if confirmed by other observations of the same kind. The real significance of this difference is not yet definite in the present observation, especially since in the first year of the period, namely in 1933, the mean weights were considerably higher than in 1934. But altogether we might say that in the last years there has been in the older school girls a certain tendency to increase in weight.

In this age group, also, the girls are somewhat heavier than the boys, particularly in 1936. The variability of body weight shows exactly the same feature as in the younger age groups. Standard deviations and variation coefficients are distinctly larger for girls than for boys in all the calendar years; but only the variability constants of the girls in the period under observation 1933 to 1936 have increased considerably in comparison with the former period 1921-1927.

## BOYS AND GIRLS 12-13 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 9)

In this age group of prepuberty there is for the first time in both sexes a parallel upward trend in the average weight. The increases are rather large, amounting to 4.59 pounds in boys and 5.16 pounds in girls (between the minimum and maximum values).

The question again arises: Are these increases in weight significant from the viewpoint of the chance theory? The highest and lowest means, their computed standard errors, and the differences may be given in a short summary:

| | Boys | | Girls |
|---|---|---|---|
| 1936 | 84.04 ± 1.035 lbs. | 1936 | 87.36 ± 1.221 lbs. |
| 1933 | 79.45 ± 1.178 lbs. | 1934 | 82.20 ± 1.243 lbs. |
| Difference | 4.59 ± 1.568 lbs. | | 5.16 ± 1.742 lbs. |

For each sex the increase in weight is almost exactly three times its standard error (2.93 times for boys and 2.96 times for girls) and therefore the increase in body weight is "significant" in the strict sense of the statistical theory. This finding seems to indicate that in 1935 and 1936 the children of this age group show a real increase of body weight in comparison with the years 1933 and 1934. Differences of this size would occur by chance alone only 3 times out of 1000.

It may be noticed further that the adjusted values of the combined years 1922-1927 are very close, especially in the case of the girls, to the observed mean weight of 1935 and 1936. Thus we may assume that there was a loss of weight in the years 1933 and 1934.

The girls in this age of prepuberty, 12-13 years of age, are through all the period of observation distinctly heavier than the boys. This corresponds to the sex differences in the general pattern of growth manifest in the years of "weight deficit" as well as in the "normal" years. The variability of body weight exhibits nearly the same trend as demonstrated before. Standard deviations and coefficients of variation are in

general higher for girls than for boys even if not as consistent as in the preceding age groups. When compared with the earlier period, 1922-1927, only the girls show in some years of the present investigation an increased variability, the boys not at all.

BOYS AND GIRLS 13-14 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 10)

It is clearly to be seen from the tabulated values that the general trend in this age group of beginning puberty is exactly the same as in the foregoing age group. The average weight went up considerably for both boys and girls. The year 1934 shows the lowest values. However, considering the comparatively small numbers and consequently high errors in 1933 and 1934, there is no real difference at all between these two years. But in 1935 there is a marked increase in the mean weight. This is true for both sexes. The increase of more than 6 pounds for girls and 8 pounds for boys is noted also in the following year of observation: 1936.

The exact differences between the highest and lowest values of the average weight are:

| | Boys | | Girls |
|---|---|---|---|
| 1935 | 94.77 ± 1.100 lbs. | 1936 | 98.08 ± 1.090 lbs. |
| 1934 | 86.71 ± 2.253 lbs. | 1934 | 91.94 ± 2.623 lbs. |
| Difference | 8.06 ± 2.507 lbs. | | 6.14 ± 2.840 lbs. |

There is no doubt that the increase in body weight of boys is significant in the strict sense of the chance theory, the difference being 3.21 its standard error. The difference for girls amounting to 2.16 its standard error characterizes the same upward trend and may, therefore, also indicate a significant increase in weight. The small number measured in 1934 and the high variability of the distribution gives a high standard error for this year and a large standard error of the difference. Altogether the upward trend for both sexes appears clear, it is the same as in the preceding age of prepuberty.

As compared with the adjusted mean weight for the former period, which comprises for this age only the years 1923-1927, it is again of interest that the values in 1933 and 1934 are distinctly below whereas the values in 1935 and 1936 are slightly above that average. Thus these consistent findings for the older school children in Hagerstown confirm or extend, indeed, Palmer's results on children 8-11 years of age insofar as there was in 1933 and 1934 a distinct drop of the mean body weight followed, however, by a still more striking rise in the immediately subsequent years 1935 and 1936. It will be of particular interest, in connection with this finding, to see what is the trend in the following years from 1937 on. Since this material is not yet fully available, it will be dealt with in another paper.

It is worth mentioning that in this group, 13-14 years of age, the girls were distinctly heavier than the boys in all the years of observation. The difference varies between 3 and 4 pounds in this age period of "filling out the figure." In contradistinction, however, with the results obtained for younger age groups, the variability of body weight

TABLE 9

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 12-13 YEARS OF AGE.

| Year | Boys | | | | | Girls | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Weight | | | | Number | Weight | | | |
| | | Range | Mean ± standard error | Standard deviation | Coefficient of variation | | Range | Mean ± standard error | Standard deviation | Coefficient of variation |
| 1933 | 146 | 50-179 | 79.45 ± 1.178 | 14.23 | 17.91 | 143 | 45-154 | 82.71 ± 1.506 | 19.01 | 21.78 |
| 1934 | 159 | 50-159 | 80.96 ± 1.242 | 15.66 | 19.34 | 148 | 50-134 | 82.20 ± 1.243 | 15.13 | 18.40 |
| 1935 | 240 | 55-144 | 83.13 ± .918 | 14.22 | 17.10 | 257 | 50-149 | 86.02 ± 1.059 | 16.98 | 19.74 |
| 1936 | 231 | 50-189 | 84.04 ± 1.035 | 15.73 | 18.71 | 256 | 50-189 | 87.36 ± 1.221 | 19.54 | 22.37 |
| 1922-27* | 681 | | 82.67 ± .595 | 15.52 | 18.77 | 614 | | 86.13 ± .664 | 16.46 | 19.11 |

*Adjusted values.



TABLE 10

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 13-14 YEARS OF AGE.

| Year | Boys | | | | | Girls | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Weight | | | | Number | Weight | | | |
| | | Range | Mean ± standard error | Standard deviation | Coefficient of variation | | Range | Mean ± standard error | Standard deviation | Coefficient of variation |
| 1933 | 82 | 45-174 | 88.41 ± 2.260 | 20.47 | 23.15 | 56 | 60-154 | 92.86 ± 2.272 | 17.00 | 18.31 |
| 1934 | 76 | 60-199 | 86.71 ± 2.253 | 19.64 | 22.64 | 63 | 50-169 | 91.94 ± 2.623 | 20.82 | 22.64 |
| 1935 | 260 | 55-149 | 94.77 ± 1.100 | 17.74 | 18.72 | 294 | 55-184 | 97.99 ± 1.060 | 18.17 | 18.54 |
| 1936 | 249 | 55-169 | 94.25 ± 1.135 | 17.91 | 19.01 | 274 | 55-154 | 98.08 ± 1.090 | 18.05 | 18.40 |
| 1923-27* | 466 | | 92.57 ± .834 | 18.00 | 19.44 | 415 | | 95.45 ± .862 | 17.56 | 18.40 |

*Adjusted values.

in girls is hardly any greater than for boys, and is moreover not consistently different in the years 1933 to 1936 from that observed in the former period 1923 to 1927.

### BOYS AND GIRLS 14-15 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 11)

For this age there are only the measurements of three different generations (1934-1936) available because the material was originally collected for the purpose of making a longitudinal study of the same school children or school generations through the four calendar years 1933 to 1936. The eldest group dealt with in the first year of the observation, i.e., 1933, was 13 years of age and consequently only from 1934 are there observations on 14-year-old children. Similarly, only from 1935 are there observations on 15-year-old children. Of course, the age group 16-17 years is then represented only in one year: 1936.

For the boys 14-15 years old there was a very considerable increase of body weight during the three years; no real increase is noticeable for girls. For the boys the difference and its mean error between 1934 and 1936 amounts to as much as 16.11 $\pm$ 3.267 pounds. Beyond doubt such a difference is statistically significant being almost 5 times its standard error. If we compare the mean weights in the single years with the adjusted value of the former period 1924-1927, we recognize the same phenomenon as observed in the immediately preceding age groups. The low average body weight in 1934 of almost exactly 92 pounds denotes a decisive drop in comparison with more than 104 pounds, the adjusted value for the combined years 1924-1927. The latter value is somewhat surpassed in 1936 when the mean weight rose to 108 pounds. Thus the boys during the stage of adolescent acceleration in growth, which in general coincides with beginning of puberty, suffered in 1934 so far as body weight is concerned. Although in general a very variable factor in growth, body weight is likely to be also a fairly sensitive index in times of physical deterioration as is confirmed by individual and medical experience.

The phenomenon is different for girls, and the explanation for the different behavior in growth development during the period of observation is perhaps not quite easy. In fact there is no consistent or significant change in body weight at all, the averages being almost constant through this period and that of 1924-1927. Of course, the numbers examined in the year of 1934 are very small, n = 18 for girls and is smaller than that of the boys (n = 37). A large standard error results as may be seen in the table. Nevertheless, the average weights, independent from their respective errors, are so close in all the years under examination that it appears to be reasonable to look for some other explanation than chance alone. It may be found in the fact that at this age, 14-15 years, girls have almost completed their growth and filled out their figure. The annual increase in the following ages for girls, in contradistinction to boys, is only small as shown by the next tables. Hence it might have happened that already in 1934 the growth impulse caused by the earlier sexual maturity in the female sex was almost stabilized and was not affected by the environmental factors of deterioration.

Except in the year 1934, there is no distinct difference in the

TABLE 11

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 14-15 YEARS OF AGE.**

| Year | Boys | | | | | Girls | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Weight | | | | Number | Weight | | | |
| | | Range | Mean ± standard error | Standard deviation | Coefficient of variation | | Range | Mean ± standard error | Standard deviation | Coefficient of variation |
| 1934 | 37 | 50-149 | 91.96 ± 2.959 | 18.00 | 19.57 | 18 | 50-164 | 103.61 ± 5.451 | 23.13 | 22.32 |
| 1935 | 148 | 65-139 | 102.47 ± 1.395 | 16.97 | 16.56 | 150 | 55-189 | 103.13 ± 1.630 | 19.96 | 19.35 |
| 1936 | 219 | 60-184 | 108.07 ± 1.384 | 20.48 | 18.95 | 290 | 60-189 | 105.07 ± 1.026 | 17.48 | 16.63 |
| 1924-27* | 255 | | 104.11 ± 1.108 | 17.70 | 17.00 | 220 | | 104.02 ± 1.245 | 18.46 | 17.75 |

*Adjusted values.
**Comparable data for 1933 not available.



TABLE 12

BIOMETRIC CONSTANTS OF WEIGHT (IN POUNDS) OF WHITE SCHOOL CHILDREN OF HAGERSTOWN, MARYLAND, FROM 1933 TO 1936. MEASUREMENTS TAKEN IN MAY OF EACH YEAR. CHILDREN 15-16 YEARS OF AGE.**

| Year | Boys | | | | | Girls | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Weight | | | | Number | Weight | | | |
| | | Range | Mean ± standard error | Standard deviation | Coefficient of variation | | Range | Mean ± standard error | Standard deviation | Coefficient of variation |
| 1935 | 88 | 65-189 | 113.64 ± 2.405 | 22.56 | 19.85 | 46 | 75-144 | 108.80 ± 2.171 | 14.72 | 13.53 |
| 1936 | 123 | 75-154 | 116.12 ± 1.581 | 17.53 | 15.10 | 134 | 60-199 | 106.98 ± 1.643 | 19.02 | 17.78 |
| | | Children 16-17 years of age.** | | | | | | | | |
| 1936 | 49 | 75-194 | 128.01 ± 3.276 | 22.93 | 17.91 | 33 | 75-149 | 112.65 ± 2.902 | 16.67 | 14.80 |

**Comparable data for the preceding years, 1933, 1934, 1935, respectively, and for the earlier period, 1921-1927, not available.

variations of body weight of boys and of girls. The variability constants, standard deviation and coefficient of variation are for all years in the same range. The same is true when they are compared with those of the former period of 1924-1927.

### BOYS AND GIRLS 15-16 YEARS OF AGE AT SUCCESSIVE CALENDAR YEARS (Table 12)

In both the years 1935 and 1936 there is no significant change in the body weight, either for boys or for girls. This corresponds exactly to the findings in the younger age groups for these calendar years. Comparable data for the preceding years or for the former period 1921-1927 are not available.

It is remarkable, however, that at this age, 15-16 years - for the first time since the beginning of the prepuberty stage - the boys considerably surpass the girls in average weight. The girls have almost stabilized their growth whereas the boys grow taller and, therefore, their body weight also increases. This well-known pattern of physical growth in the sexes is still more evident in the next age as the following data make clear.

### BOYS AND GIRLS 16-17 YEARS OF AGE IN 1936 (Table 12)

For reasons explained above only one generation, the 13-year-old of 1933, is available at the age 16-17 years. Therefore a comparison of the weight constants with other generations in Hagerstown is not yet possible. However, the pattern of sex difference in favor of boys is more marked at this age. The mean body weight for boys amounts to 128.01 $\pm$ 3.276 pounds, for girls to 112.65 $\pm$ 2.902 pounds. The difference is more than 15 pounds. There is no doubt that this is a statistically significant deviation although the sample is small and therefore affected by a relatively high standard error. In this age, the variability constants are distinctly higher in the male sex, due to the greater vertical growth of male adolescents. It remains to be seen in a later survey how this pattern of average growth in weight compares with the development in height.

## SUMMARY AND DISCUSSION

The material used in the present paper covers an extensive investigation on the growth of white school children of Hagerstown, Maryland, aged 6 to 16 years. It represents the first of a series of studies dealing with the pattern of growth and annual variations in the height and weight of children. The material was collected by the U. S. Public Health Service at Hagerstown during the years from 1933 through 1936 and represents to a certain degree the continuation of former studies on the growth of school children of the same community published in several papers by Palmer. Data regarding height and weight of these generations are available for three more years, 1937-1939, and will be presented in a later publication.

The observations used in this paper consist of the records of 14,401

weight measurements taken in May, 7,134 weights of boys and 7,267 of girls in the four successive years of the period. The number of observations varies in the successive years because from year to year one new generation of school children, 6 years of age, enters the investigation. The analysis of the data consists of the age and sex comparison of the average weights with their standard errors, the standard deviations and the coefficients of variation.

The principal results of the new Hagerstown growth study are illustrated in Figure 1 and may be summarized briefly as follows:

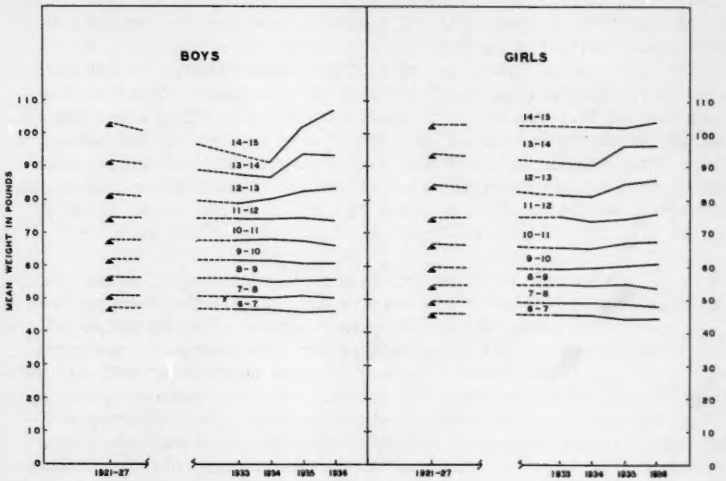


FIGURE 1

a) Boys and girls from 6 years of age (6 - 7 years) through 11 years of age (11 - 12 years) exhibit no consistent or statistically significant change in mean body weight during the single calendar years from 1933 to 1936. Also, when compared with the adjusted values of a period in the previous decade, the combined years 1921-1927, there is no essential or significant variation in body weight for these ages. The results are therefore in almost perfect agreement with Palmer's former findings on the white elementary school children 6-11 years old of this community. There occur some minor annual deviations in almost every age group, however, and the details are reported in the text and tables. There is, for instance, in the youngest age group, 6-7 years, a certain decrease of body weight noted in both sexes. However, it is not statistically significant. There is further for the ages 9-10 and 10-11 years a slight but consistent inverse trend in boys and girls to be mentioned; during the period of observation the mean body weight of the boys went down, that of the girls went up. Yet these differences, too, stay within the limits of chance fluctuations. Since the pattern of growth in boys and

girls is not yet fully developed, inverse trend during the same calendar years and similar economic conditions may be mentioned without giving too much emphasis to it.

b) The most striking result of this investigation is the fact that the older school children, boys and girls from 12 years of age and up, exhibit a statistically significant increase of mean body weight. The maximum annual increase for boys 12 years old amounts to 4.6 pounds and for girls 5.2 pounds. Considering the standard errors, differences of this size would occur by chance alone only 3 times out of 1000. There is little reason to doubt that such change in average body weight may have a real meaning, particularly when the same phenomenon of increase occurs in the next ages of prepuberty and beginning adolescence. In the age group 13-14 years, for boys the maximum annual increase amounts to 8.1 and for girls to 6.1 pounds in the period of observation. In the age 14-15 years, the maximum annual increase of body weight for boys amounts to as much as 16.1 pounds. This difference being nearly 5 times its standard error denotes that a real increase of body weight has taken place. The girls at this age have almost stabilized their growth and exhibit even in the succeeding ages of sexual maturity no more essential increase in weight growth. This sex difference in the change in weight will be left to be discussed later in connection with the variations of stature.

c) The phenomenon of a real increase in the body weight of the older school children in Hagerstown is perhaps more significant when the results from 1933 through 1936 are compared with the adjusted values of the former decade. So far as comparable data are available, namely for the 12, 13, and 14 years old children, the mean weights for 1933 and 1934 are distinctly below and those for 1935 and 1936 are somewhat above the average for the previous decade. This means that a distinct drop of body weight in the years 1933 and 1934 took place, followed soon, however, by a still more striking rise in the immediately subsequent years 1935 and 1936. Whatever the reasons (or our explanation) may be for this new finding, it will be of particular interest to watch the trend of growth in the following years from 1937 on.

d) The variability of body weight, as measured by the absolute parameter of standard deviation and the relative parameter of coefficient of variation, does not vary consistently in the single calendar years of the period under observation for the different age groups. Of course, the values go up with increasing age due to the steadily dispersing effect of growth. However, two points may be mentioned. First, the variability constants are almost in all age groups distinctly higher in girls than in boys. But more striking in this respect is that during the years of the present observation, 1933 to 1936, there is a distinctly greater variability of body weight in the girls than in the boys when compared to the former period 1921-1927. On the other hand, there is no correlation whatsoever between body weight itself and its variability constants in the four years. For instance, in the years 1933 and 1934 with low average weights the standard deviations are not consistently lower or higher than in 1935 and 1936. Thus it might be doubtful if the greater variability of girls in the later years has any other meaning than the expression of a sex character.

## CONCLUSIONS

Body weight is certainly a highly variable element in growth since it depends on a series of constitutional and environmental factors. But it is also an index of periods of physical deterioration. The findings, that for the older school children of Hagerstown there was a distinct weight decline in 1933 and 1934 as compared with former and later years, extend the results of Palmer's study on younger children. Palmer's data showed, for the girls at least, a higher proportion of underweight individuals in 1933 and 1934 and, furthermore, a lower average annual gain in weight from May 1933 to May 1934 than in the earlier period 1921-1927, as a whole. The considerable increase in weight of the older children in the years from 1935 on are in fairly good agreement with the tendency to a general increase of growth observed all over the world and especially demonstrated for German school children after the last World War. The actual reasons for such a tendency are not yet clear. This trend may demonstrate the influence of various "growing" years or, more strictly speaking, the influence of varying natural and social environmental factors such as climate, hours of sunshine and rainfall, or the socio-economic characteristics of the years under observation. It may also be reasonable to suppose that such a world-wide socio-biological transformation as the general birth decrease in our time is indirectly involved in the growth phenomenon.

It remains to be seen by further investigation in Hagerstown if this tendency will continue. The behavior of the biological constants of growth in different calendar years may serve as an index of the varying socio-economics conditions. Thus from the standpoint of public health as well as of the physiology of growth further critical consideration and discussion of the possible factors involved are desirable on the basis of the new facts and figures in preparation.

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# PIAGET'S QUESTIONS APPLIED TO ZUNI CHILDREN[1]

WAYNE DENNIS AND R. W. RUSSELL[2]

## INTRODUCTION

It is of utmost interest to determine whether the thought tendencies which have been investigated by Piaget are characteristic of children universally, or whether these tendencies are exhibited only in certain milieu. We are particularly concerned with the ideas which Piaget discussed in "The Child's Conception of the World" (3), namely, animism, realism and artificialism. Up to the present time the questions which Piaget reported in this important publication have been asked only of European and American white children. Mead's (2) report concerning the apparent lack of animism in Manus children of the Admiralty Islands does not constitute an exception to the above statement, since Mead did not employ Piaget's methods. It remains to be shown that Mead's techniques are adequate to reveal animistic tendencies in children. For this reason, we cannot agree with Mead that her results are at variance with those of the Genevan investigator.

In the summers of 1937, 1938 and 1940 we employed certain of Piaget's methods with some children who were attending the government day school in the farming village of Nutria on the Zuni Indian Reservation. The investigations of the first two summers were conducted by the senior author; those of the summer of 1940 were carried out by the junior author. The questioning was conducted in English, which is, of course, the language used in the school. Since the native language is spoken in the children's homes, and English is learned chiefly at school, no child was questioned unless he had been in attendance for at least two years and unless he showed an ability to name the objects about which our questions were asked.

In all, 24 children were examined, 15 boys and 9 girls, but not every one was examined with reference to each topic. On the other hand, some children were examined on the same topic in each of two or even all three summers. The number of children examined in reference to each topic will be reported in connection with the report of results. The subjects ranged in age from 8 to 16 years.

Prior to the examinations conducted by each investigator, he spent one or more days at the school as a visitor, playing with the children, speaking with them and gaining their confidence. Each investigator explained that he taught white boys and girls that he was anxious to become acquainted with Zuni children, and that he wanted to ask each of them some questions. The subjects were friendly, and rapport was good throughout. Each subject was examined individually in a room separated from the classroom.

[1]*This research has been made possible by grants-in-aid to the senior author on the part of the Social Science Research Council, whose support is gratefully acknowledged. Appreciation is also expressed to Mrs. Roy Poe and Mrs. Mary E. Sell, teachers at the Nutria Day School, for their willing cooperation.*

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## ANIMISM

The topic of animism was the one on which the most time was spent. Questions concerning which items in a series of objects were living and which were dead were asked in each of the three visits to the school. In 1938 and in 1940, a procedure for the study of animism which we have described elsewhere (6) was employed. This method asks essentially the same questions as did Piaget, but it makes use of a standardized list of objects, selected because of their universality. In 1937, this procedure had not yet been adopted, but the questions asked were the same, and many of the objects used were the same, as those later employed.

In all 24 children between 8 and 16 years of age were examined with reference to animism. Some were examined during each of two summers, a few in all three summers. The total number of examinations was 37.

All of the answers which were obtained from the Zuni subjects were of the same types as those described by Piaget and which also were found in our studies of white American children. Typically, in Stage 1 the knife was living because it could cut, the button employed in the experiment was dead because it was broken, etc. In Stage 2, the motionless objects were said to be dead, but a watch, clouds, moon and the wind were alive because they moved. A pencil was living when the experimenter rolled it on the table but not when it lay still.

Illustrations of answers at the higher stages are few for Zuni subjects because only 4 of the 37 examinations were scored as being above Stage 1. Twenty-eight of the 37 were in Stage 1, while 5 subjects showed that they had no concept of living things.

While the number of subjects at any age level is too small to justify serious comparison with the white groups which we have studied (4), the evidence tends to show that the Indian children are retarded. Of the 33 examinations conducted with children under 13 years of age, 31 sets of answers revealed either "no concept" or Stage 1. In our experience with white groups of normal intelligence and of ages comparable to the Zuni children we have found no such preponderance of no concept and Stage 1 answers. However, the number of Zuni examinations is too few to permit a statement concerning the reliability of the difference.

With 13 subjects it was possible to compare records obtained in two different summers. Some of these records were separated by one year and others by two years. Eight of the 13 subjects showed no change, 3 subjects advanced one stage in the later test and 2 retrogressed one stage. There is no indication that these subjects, on the whole, were showing progressive changes in their concepts.

## IDEAS OF CONSCIOUSNESS

In the summer of 1940, 14 subjects were questioned concerning the ability of each object in our standardized list to "feel" when it was touched. The question concerning the first eight objects was, "Does the _____ feel when I touch it?", the experimenter touching the object as he asked the question. The question was changed appropriately for objects not immediately present (5). Eight of the 14 subjects were in the no concept stage; that is, they answered at random or answered "yes" or "no"

uniformly in regard to all objects without respect to their condition or characteristics. Three subjects gave Stage 1 answers; that is, all objects which were useful and in good condition were said to be able to feel. Two subjects limited such consciousness to man, or to man and animals, and hence were classified as in the adult stage. No Stage 2 and Stage 3 answers were obtained. On the basis of the present evidence we cannot determine whether this fact was due to the small number of examinations or whether these stages do not occur in Zuni children. We suspect that the former interpretation is the correct one.

## THE ORGAN OF THOUGHT

The questions concerning the remaining topics were asked only in the summer of 1937. They are taken from the examples of Piaget, and will be familiar to those who are acquainted with "The Child's Conception of the World." The chief difference between our method and that of Piaget lies in the fact that we attempted to ask the same questions of all subjects, and tried to use the same objects of reference in all cases, whereas Piaget varied his questions and interrogated one child about objects which were not referred to in the case of other subjects.

One group of queries asked in 1937 had to do with the organs by which various functions are performed. The initial questions were intended merely to establish rapport. They were, "What do you hear with?" "What do you see with?" "What do you run with?" These are answered by white children in a stereotyped manner and were answered in the same way by the Zuni subjects. Then each subject was asked the final question, "What do you think with?" to which Piaget has found that young children reply "with the mouth." Older subjects, of course, give the learned answer that it is done with the heart or the head.

Ten Zuni subjects, ranging in age from 8 to 13 years, were examined. Three gave no answer or else said they did not know. Two, however, one of eight and one of nine years of age, said thinking was done with the mouth. Three gave the learned answer that it is done with the heart or the head. One answered "the eyes" and one answered "arm." The latter was probably an answer by analogy to the answers of the preceding questions; the other reply may also have been this, or it may have had reference to visual imagery in thinking. It is of interest that the answer given by Piaget's subjects also was given by Zuni subjects. However, most of the Zuni children were too old to lead one to expect them to give the childish conception.

## DREAM REALISM

Each of 9 subjects was asked if he sometimes dreamed when he was asleep. After an affirmative answer was received, he was asked further, "Do you see your dreams or do you hear them or do you see and hear them?" Following this, Piaget's question relative to the location of dreams was put, "Where are they when you see them?" (or "when you hear them" according to the previous answer of the subject).

To this question 4 replied that they did not know; these subjects ranged in age from 8 to 13 years. Four, varying in age from 8 to 12

years, placed the dreams externally as did many of Piaget's subjects; only one subject gave the learned answer "in the head."

After this question, we followed Piaget's recommendation and suggested that dreams were in the head, excluding of course in this procedure the child who had already given this answer. Only one of the remaining eight accepted this suggestion; all the rest denied that our idea was correct. This, too, is in accord with Piaget's experience (3).

Then came the last inquiry concerning the objectivity of dreams: "If someone else were near you when you had a dream could he see or hear your dream?" Six of the nine subjects answered "Yes." This could not have been the result of a general tendency to give affirmative answers, since the immediately preceding question elicited predominantly negative replies.

## ARTIFICIALISM

The last set of questions had to do with notions concerning the origin of a number of objects chosen so that they would be familiar to our subjects. In this instance we did not employ a rigidly standardized procedure but asked our questions variously in the following forms: "Where do we get _____?" "Where does _____ come from?" "How do we come to have _____?" An attempt was made throughout to make these questions real to the subjects and to interest them in solving these problems. Nine subjects were employed; these were the same nine children who have been referred to in the immediately preceding sections, and varied in age from 8 to 13 years as shown in Table 1.

TABLE 1

ORIGINS OF OBJECTS

| | Origins | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subject: Age: | Leo 8 | Ant 9 | Neil 9 | Nal 9 | Rac 10 | Car 10 | Jon 11 | Jac 12 | Lup 13 |
| matches | store | store | made | store | store | store | made | store | store |
| clouds | d. k. | d. k. | rain | sky | sky | smoke | smoke | smoke | d. k. |
| coffee | store | store | flour | store | store | store | made | store | store |
| trees | hill | d. k. | ground | ground | ground | ground | ground | ground | ground |
| rain | sky | sky | sky | sky | clouds | clouds | sky | clouds | clouds |
| corn | | fields | planted | planted | planted | planted | planted | planted | planted |
| cactus | | | God | ground | n. a. | ground | d. k. | ground | d. k. |
| hills | n. a. | d. k. | sand | n. a. | d. k. | grows | dust | d. k. | made |
| eggs | | store | hen | hen | hen | hen | hen | hen | hen |
| shirts | | store | store | made | store | store | city | store | store |
| rocks | | ground | sand | ground | ground | brook | big rocks | ground | ground |
| sun | | n. a. | of yellow | sky | sky | fire | sky | fire | d. k. |
| pencil | | store | made | store | made | made | made | store | store |
| sky | | | d. k. | d. k. | d. k. | smoke | d. k. | heaven | d. k. |
| brook | | d. k. | rain | d. k. | made | springs | rain | made | made |
| dam | | | made | d. k. | d. k. | made | made | made | d. k. |
| chicks | | d. k. | eggs | eggs | store | eggs | eggs | eggs | d. k. |
| lambs | | d. k. | God | mother | n. a. | mother | sheep | sheep | sheep |
| snakes | | water | brooks | n. a. | n. a. | ground | | rocks | d. k. |

The answers are shown in brief in Table 1. In this table "n. a." indicates "not answered" and "d. k." denotes that the child said he did not know.

Table 1 reveals a number of practical and common sense answers. All children know that matches are made and come from a store. However, coffee is likewise a store product. Trees, and corn and cactus, on the other hand, are known to grow from the ground. Answers to a supplementary question as to whether these objects were planted by people (these answers are not shown in the table) revealed that all children knew that corn must be planted, that trees were sometimes planted, but that cactus is never planted. There were no artificialistic answers regarding the origin of cactus, although one might have expected such.

In regard to clouds and hills, some artificialistic and some naturalistic theories were evolved, and each answer was apparently an independent solution. Three Zuni children believed that clouds are due to smoke arising from stoves, a theory noted by Piaget. The others who answered the question held that the clouds came from the air, from the sky, etc. Whether clouds were indirectly traceable to smoke in these instances was not determined.

Four origins for hills were recorded. Two subjects held that hills were made of dust and sand piled up by the wind, a process often observable in the Southwest. One girl claimed that hills grow from the ground. One girl said someone piled up the earth to make the hills.

In regard to the origin of rain, the usual answer was that it came from the clouds. Since the Zuni belief is that men can induce rain by the proper use of dances and other ceremonies, four of the initial answers were followed by a second question, "Can people make it rain?" Four of five Zuni children held that people cannot make it rain. Only one gave the adult reply, namely, that prayer sticks are effective agents in bringing rain. This ignorance on the part of the children checks with the statement of Zuni adults that ceremonies are seldom explained to the children until they are beyond twelve years of age.

The origins of eggs, shirts, pencils, dams, chicks and lambs were in general correctly known. On the whole very few artificialistic answers were given. Brooks, however, were thought by three subjects to be man-made. Some of the other answers, while superficially naturalistic, might have proved to be the result of an artificialistic interpretation had the question been followed up. However, in a few instances replies of a naturalistic tenor were pursued further with results consistently of a non-artificialistic nature. For example, Neil, who said the sun was made "of yellow," when asked suggestively if some person made it, said no.

Again our data are only indicative of a problem; we cannot attempt quantitative comparisons of the artificialism of Zuni and white children because not sufficient data relative to either are at hand. However, tentatively it would appear that the Zuni subjects give fewer artificialistic origins than do Piaget's subjects. If this proves to be the case it may well find its explanation in the fact that the Zuni child is more closely associated with phenomena of generation and growth and much less in contact with articles of human manufacture. The meager material culture of primitive peoples may lead to a lesser degree of artificialism in the primitive child.

## DISCUSSION

The results here reported should be considered as the outcome of an exploratory investigation. They are not sufficiently numerous to enable one to make more than the roughest comparisons with data from white subjects. On the quantitative side, however, we cannot refrain from remarking that Piaget's data, no less than these, are insufficient for comparative purposes.

One question which demands serious attention is that of the language factor. The Zuni subjects are bilingual. English is merely an auxiliary language. Since the child first learns Zuni and continually uses it except when he is in school, it is altogether likely that he thinks in Zuni and does a considerable amount of translation in order to understand and to answer questions such as those here reported. In the course of this translation, much distortion of meaning may take place.

It would be most valuable could each investigation of child thought be conducted in the native language by someone thoroughly familiar with that language. This was out of the question in the present instance. However, in connection with the questions concerning animism, we attempted to familiarize ourselves with the Zuni concepts to which the child is exposed and to learn the Zuni words into which the child may have translated our question. In regard to the animistic use of language, the Zuni practice would seem to approximate our own. In referring to natural objects many anthropomorphic terms are used, terms which are comparable to our speaking of an angry cloud, a treacherous river, a fierce wind, etc. But in respect to the Zuni term which designates life or animation, ho'i, each of four native informants insisted that it is used just like our English term "living"; i.e., it is used only in reference to persons, animals and plants. The Zuni child's extension of the term to cover all useful and undamaged objects is wrong from the point of view of the Zuni adult, and is quite comparable to the tendencies of the white American and European child. Our informants flatly denied Bunzel's statement (1) that to the Zuni all objects are animated. Bunzel may, however, have been referring primarily to the Zuni's metaphorical use of anthropomorphic terms, although she mentions specifically the word ho'i about which we questioned our informants.

In addition to persons, animals and plants, the Zuni speak of supernatural beings as living; in that respect, also, their usage parallels ours.

## SUMMARY

A considerable number of the questions employed by Piaget and reported in "The Child's Conception of the World" were put to some or all of 24 Zuni school children who ranged in age from 8 to 16 years. In regard to each topic, the answers obtained from the Zuni children comprised all or nearly all of the types described by Piaget; they are also like those recorded by ourselves in previous studies. No new types of answers were obtained. In other words, the conceptions of the Zuni child seem not to differ from those of Piaget's French-speaking and of our American subjects. Whether there is a difference in the age-incidence of various answers

as between Zuni and European or American children cannot be said at the present time because the data are not sufficiently numerous. The data available suggest that Zuni children on the whole may persist longer in the first stage of animism than do white American children, but that the Zuni subjects develop fewer artificialistic notions or else forsake them at an earlier age. If these differences prove to be real, they may be the result of specific environmental factors rather than representing a general difference between primitive and civilized children.

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# APPARATUS FOR MEASURING OXYGEN CONSUMPTION IN HUMAN SUBJECTS AT REST AND AFTER EXERCISE

NATHAN W. SHOCK, ERIC OGDEN AND P. M. TUTTLE[1]

In a long term study of adolescence undertaken by the Institute of Child Welfare, particular interest was centered on the relation between physiological homeostasis and maturity and hence an intensive study of physiological readjustments following displacing stimuli was made. A study of the recovery of oxygen consumption after severe exercise was included as one index of homeostasis. For the collection of data adequate for estimating rate of change in oxygen consumption after exercise the following apparatus was designed and constructed.

The apparatus to be described offers definite advantages over any previously used in that it provides for continuous determinations of oxygen consumption over successive periods, the duration of which may be varied. The method is essentially a combination of the methods of Tissot (3) and of Hill (1,2) and involves the collection of expired air in one of a pair of Tissot spirometers, while the air expired during the previous period is being measured, sampled, and discarded from the other.

To insure the flexibility necessary for the collection of small samples in rapidly changing conditions without the necessity of making an inordinately large number of analyses in experiments of longer duration, two pairs of spirometers were used, a large pair for the longer periods and a smaller pair either alone or in conjunction with the larger pair for short or intermediate periods.

## TWO LARGE SPIROMETERS

Two large spirometers (A and B, Figs. 1 and 2) were used primarily for the collection of expired air during periods of basal determination or other stable circumstances where relatively long periods of air collection were desired.

When expired air was to be collected in the large spirometers (A and B) the flexible rubber hose from the mercury expiratory valve (W) was connected to the opening of the T-valve (G) (the arrangement shown in Fig. 2 is different and is discussed later) which was turned so that the expired air passed directly through a one-inch pipe into a one and one-half inch T-valve (C), which directed it through a one and one-half inch pipe, past one or the other of the T-joints on which were situated the discharge valves O and N respectively, into the large fifty-liter spirometer (A or B). These spirometers which had a full range of movement of 55 cm. had a factor of 0.871 L/cm. at S.T.P. The dead space between the valve (C) and the bell was 1.25 liters. The spirometer tanks had concentrically placed drums to minimize the water surface exposed to the air within them. Each spirometer carried a thermometer (P) and a stirrup which was attached by a chain to a counterbalance. The weight of the

[1]*From the Institute of Child Welfare and the Division of Physiology Medical School, University of California.*

*Grateful acknowledgment is made to the Work Projects Administration (O.P. No. 665-08-3-30, Unit A-8) for assistance in the construction of this apparatus.*

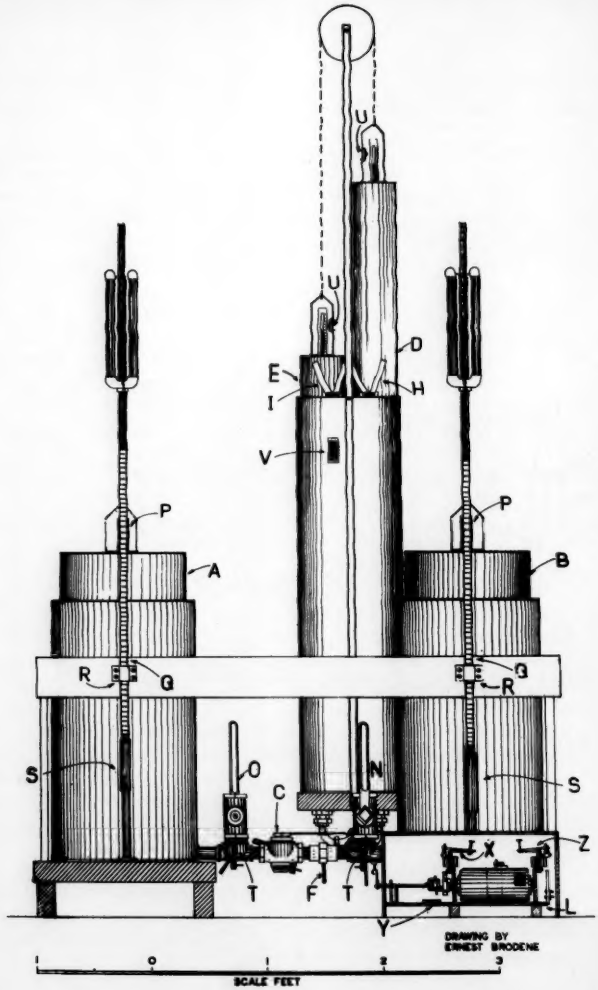


Fig. 1. View of apparatus from operator's side showing contacts and motor for automatic change-over for small 9.19 liter spirometers.

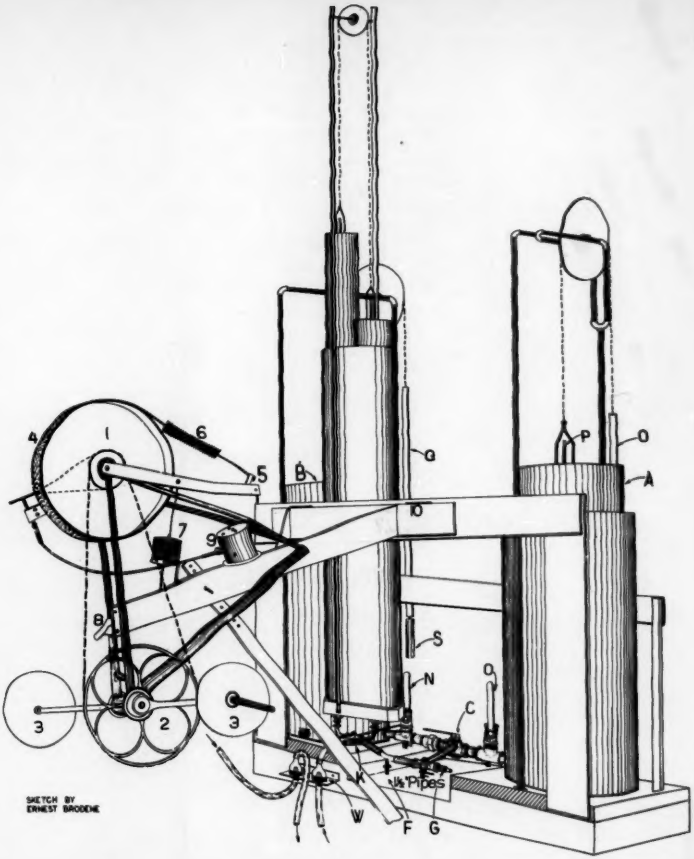


Fig. 2. Front view of apparatus with bicycle ergometer in position for arm exercise.

chain was calculated to compensate exactly for the change in weight of the spirometer as it rose out of the water. The total friction at the pulley was such that an excess weight of 5 gm. caused the bell of these spirometers to fall. Readings were made from the moving meter-scale (Q) to the stationary zero mark (R).

At the end of the collection, the stop-cock (C) was turned, directing the stream of air into the other spirometer; and after readings of volume and temperature had been made, the counterbalance (S) was unhooked, and the stop-cock (N or O) opened to the atmosphere. When the spirometer was

half discharged the stop-cock (N or O) was closed while a sample of gas for analysis was withdrawn from the sample cock (T). A series of samples taken at 10 cm. intervals between complete fullness and complete emptiness indicated that mixing within the spirometers was adequate (Table 1). When the sampling was finished the spirometer was completely emptied, the discharge valve (N or O) closed, and the spirometer was ready for the next collection. In practice, it was found possible to take the readings and sample and to empty the spirometer completely, so that it would be ready in one minute from the time the collection was completed.

TABLE 1

SAMPLING ERROR OF GAS CONTENTS OF SPIROMETER

| Spirometer Reading Cm. | $CO_2$ Analysis | | $O_2$ Analysis | |
|---|---|---|---|---|
| | I | II | I | II |
| 50.0 | 3.142 | 3.147 | 17.24 | 17.22 |
| 40.0 | 3.157 | 3.157 | 17.20 | 17.20 |
| 33.0 | 3.151 | 3.176 | 17.19 | 17.21 |
| 26.0 | 3.118 | 3.155 | 17.16 | 17.13 |
| 20.0 | 3.120 | 3.140 | 17.19 | 17.19 |
| 13.0 | 3.165 | 3.165 | 17.23 | 17.24 |
| 8.0 | 3.146 | 3.149 | 17.22 | 17.23 |
| 2.0 | 3.147 | 3.150 | 17.26 | 17.25 |

SMALL TWIN SPIROMETERS

Two small aluminum spirometers of 9.19 liters capacity (D and E, Fig. 1) were used for rapid measurement of small volumes of expired air. These were suspended in the same tank and so connected over a pulley that each formed a counterbalance for the other at all positions. The dimensions were approximately 15 by 100 centimeters. The full range of movement was about 60 cm. In order to use these spirometers, the flexible rubber tubing from the expiratory valve (W) (Fig. 2) was connected to the inlet part of a four-way valve (K) (Figs. 2 and 3). Air passed through the double two-way valve (K) (Figs. 2 and 3) into one of the spirometers (D), which rose as more air entered. As it rose, the other spirometer (E) fell, driving its contents through the other passageway in the double two-way valve (K) and out by way of the hand-operated T-valve (G) to the atmosphere. During this discharge of air, a sample was taken from the small side tube (F), which was ordinarily closed with a pinch-clamp. As the spirometer (E) became completely emptied the brass bar (U) (Fig. 1) on the top of this spirometer bell closed an electrical circuit across the open contact slot (I). This was in circuit with the relay (X) which momentarily closed a circuit that energized motor (L) which immediately turned the double two-way valve (K) in such a way that the incoming stream of air was directed to the other spirometer (E), and the outgoing stream of air from the full spirometer (D). The motor ran only momentarily, since, when the shaft had turned three-quarters of a revolution, sufficient to change the position of valve (K), a contact (Y) was made which broke the current to the motor through relay (Z). A signal magnet operating on a moving paper kymograph was actuated at the end of each

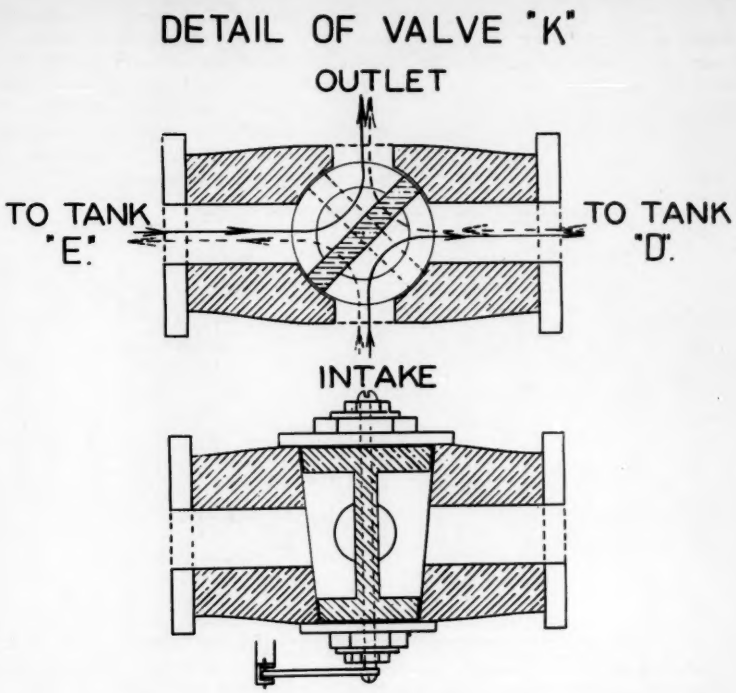


Fig. 3. Detail of motor driven automatic change-over valve (K) leading to and from 9.19 liter spirometers.

collection of 9.19 liters. While the previously collected 9.19 liters was being discharged, samples of it were taken for gas analysis. If the air was coming so quickly that there was not time to take a sample from each 9.19 liters, or if the experiment was to continue so long and conditions were changing so slowly that it would be uselessly laborious to make an analysis from each 9.19 liters, the T-valve (G) was so set that, instead of discharging into the atmosphere, the 9.19-liter spirometer discharged into either of the previously described pair of 50-liter spirometers. In these, any given number of 9.19-liter samples (up to five) could be stored, mixed, and sampled at leisure.

Figure 4 is a circuit diagram to indicate the arrangements whereby the filling of each spirometer provided for its own emptying and for the filling of the other. It illustrates also the mechanism by which the starting of the paper polygraph was synchronized with the beginning of the collection of the first sample of expired air. No movement of the

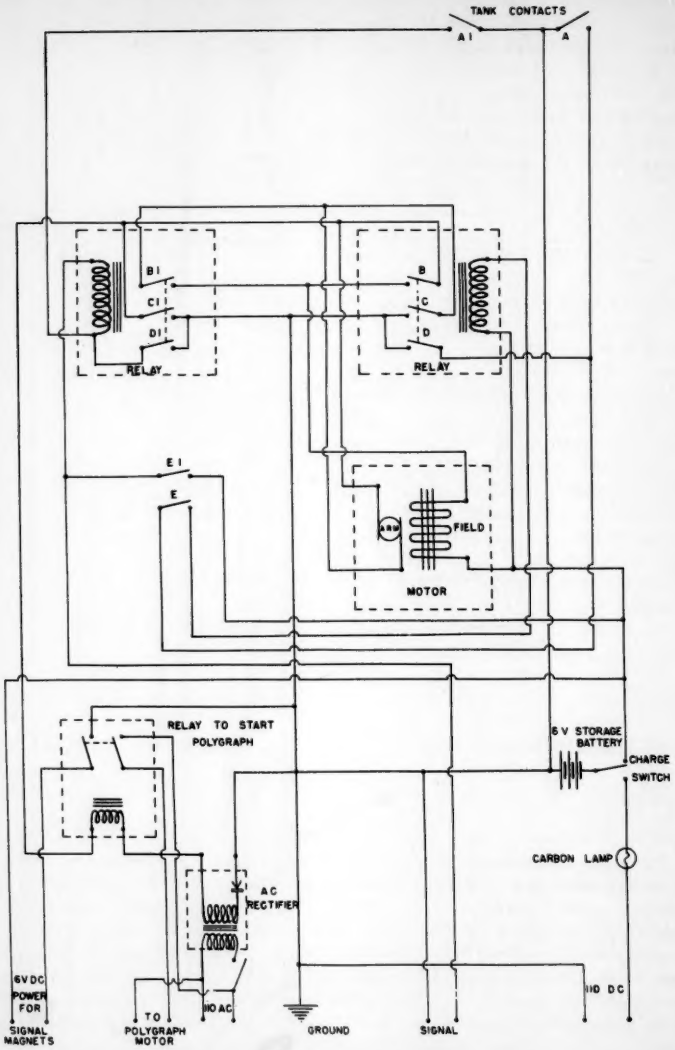


Fig. 4. Wiring diagram of contacts, relays and motor driving the automatic change-over valve for the 9.19 liter spirometers.

valve motor is initiated by contacts A and A', which are attached to the tanks. Closure of either of these contacts operated the corresponding relay. Contacts B and C, and B' and C', started the motor and controlled its direction. Contacts D and D' were provided to keep the relay closed until the valve change was completed. Contacts E and E' stopped the motor at the end of the valve change. These contacts were held closed by springs, and one or the other was caused to open by the valve-changing motor at the end of the valve rotation.

## ERGOMETER

In order to provide facilities for varying the oxygen utilization, a bicycle ergometer was arranged so that the subject might operate it with his hands while lying supine by the metabolism apparatus.

The ergometer was hinged (10) (Fig. 2) so that it could be swung up out of the way. When in use it was supported by a pin and perforated brace (below numerals 7 and 9 diagonally down to the right), the different perforations allowing adjustment for individual convenience.

The pedals were removed and hand guards (3) provided to prevent the hands from getting between the chain and the large sprocket (2). Load was provided by a brake drum and band (4) held by a spring (6) adjustable by a wing screw (5) to a bar anchored down by a metal sylphon tambour (7). Traction on the drum, tending to raise the bar (5), stretched the tambour which, in turn, pneumatically actuated a similar metal tambour writing on the paper polygraph a record of the tension. At each revolution one pedal closed the flexible brass contacts (8), recording on the polygraph the number of revolutions. Thus there was an automatic record of the number of revolutions per minute and of the tension against which these were made.

An automobile speedometer (9) gave the subject a visual opportunity to check the constancy of his rate of doing work, and was used to provide an urge to maximal or sustained activity. A sample of the record obtained from the paper polygraph in a typical experiment is shown in Fig. 5.

## CALIBRATION OF ERGOMETER[2]

In order to determine the amount of work done in turning the crank of the ergometer at different tensions of the brake drum, the following experiments were performed. The shaft of an electric motor was attached directly to the shaft of the large sprocket (A, Fig. 6). The frame of the motor was suspended between two bearings and was thus free to rotate. A lower arm (L') was attached to the motor frame and rested on a balance. Thus it was possible to measure the torque on the motor armature by reading the balance attached to the motor frame through lever L'. The force exerted at each degree of tension of the ergometer drum was measured on a balance (F', Fig. 6) through the lever arm L' (Fig. 6). (This lever arm was actually attached to the frame of the driving motor, but for convenience of illustration is shown as attached to the driving sprocket

[2]*Our thanks are due to Prof. R. G. Folsom, of the Department of Mechanical Engineering, for advice and assistance, as well as the loan of equipment in making the calibration curve for the ergometer.*

wheel of the ergometer.) The force F' was measured to ± .01 pound. From the data obtained it is possible to compute the work done as follows:

$$W = F\,S$$

Where W = work in Kg.m.; F = force in Kg.; S = distance in M.

$$\frac{F}{F'} = \frac{L'}{L}$$

Where F = force exerted on ergometer crank; F' = force registered on balance attached to dynamometer lever; L = length of ergometer crank arm; and L' = length of dynamometer arm.

$$F = \frac{F'L'}{L}$$

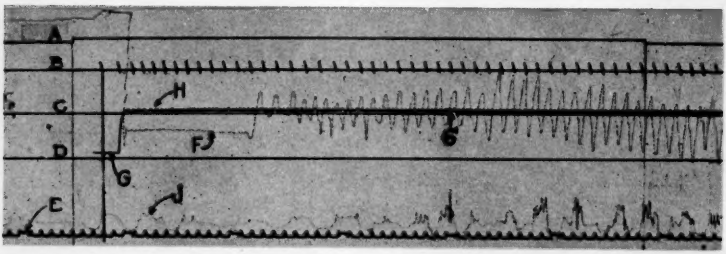


Fig. 5. Sample polygraph record obtained during arm exercise experiment. Record reads from left to right. Signal magnet A indicates time at which small 9.19 liter spirometer began to fill - next mark on this line indicates the end of the collection of 9.19 liters of expired air.

B - Each mark indicates one revolution of the ergometer crank.

C - Time line, marking minutes (6' marked) from beginning of experiment.

D - Signal marker to indicate time at which systolic and diastolic blood pressure were read (no pressures could be read during the exercise, but the first reading was made within 10 seconds of the conclusion of the exercise).

E - Time line, marked in seconds.

F - Continuous record of pulse rate obtained from pneumatic cuff attached to subject's ankle and inflated to 50 - 60 mm.Hg; recorded pneumatically through metal tambour.

G - Base line for recording tension on ergometer.

H - Line showing setting of friction brake on ergometer, pneumatically recorded through metal tambours connected with copper tubing.

J - Respiration curve, pneumatically recorded through pneumograph around thorax.

Since the motion is rotary, the distance traversed is

$$S = 2\pi L n$$

Where n = number of revolutions of the crank

$$W = \frac{F'L'}{L} \times 2\pi L n$$

$$= 2\pi L' \times F' \times n$$

Since L' = 32 cm. it is possible to calculate the amount of work done.

Table 2 shows the values obtained for F' at different tensions on the drum expressed in terms of the height of the curve from the polygraph record (see Fig. 5).

The values for $2\pi L'$ (or work in Kg.m. per revolutions of the crank) are placed against the height of the polygraph curve (in mm.) in Fig. 7.

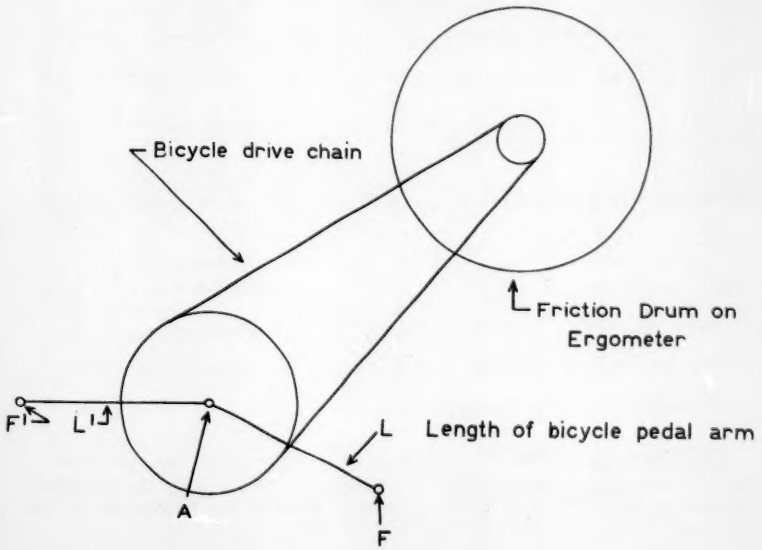


Fig. 6. Diagram of method used to obtain dynamic calibration of bicycle ergometer.

L - Length of bicycle pedal arm.

L' - Length of lever arm attached to frame of motor at one end (A) and to balance at other end (F') to measure torque exerted by motor.

F - Force applied to bicycle pedal by subject.

F' - Force exerted by motor (measured on balance).

TABLE 2

DATA FOR CALIBRATION OF ERGOMETER

| Test No. | Height of Curve mm. | Height of Base Line m. | H. (Col.2 - Col.3) | F' (Lbs.) | 2 F'L' (Kg.M.)* |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 42.5 | 32.1 | 10.4 | 2.50 | 2.281 |
| 2 | 42.5 | 32.1 | 10.4 | 2.48 | 2.264 |
| 3 | 36.2 | 31.9 | 4.3 | 1.23 | 1.123 |
| 4 | 36.0 | 31.7 | 4.3 | 1.23 | 1.123 |
| 5 | 35.5 | 30.9 | 4.6 | 1.20 | 1.097 |
| 6 | 35.5 | 30.9 | 4.6 | 1.20 | 1.097 |
| 7 | 35.5 | 30.9 | 4.6 | 1.20 | 1.097 |
| 8 | 35.5 | 30.9 | 4.6 | 1.20 | 1.097 |
| 9 | 35.5 | 30.9 | 4.6 | 1.28 | 1.170 |
| 10 | 35.8 | 30.9 | 4.9 | 1.33 | 1.215 |
| 11 | 35.5 | 30.9 | 4.6 | 1.21 | 1.105 |
| 12 | 40.5 | 30.9 | 9.6 | 2.38 | 2.175 |
| 13 | 40.0 | 30.9 | 9.1 | 2.30 | 2.100 |
| 14 | 39.5 | 30.9 | 8.6 | 2.10 | 1.919 |
| 15 | 38.8 | 30.9 | 7.9 | 2.00 | 1.827 |
| 16 | 38.5 | 30.9 | 7.6 | 1.95 | 1.780 |
| 17 | 42.2 | 30.9 | 11.3 | 2.65 | 2.420 |
| 18 | 42.0 | 30.9 | 11.1 | 2.65 | 2.420 |
| 19 | 45.5 | 30.9 | 14.6 | 3.32 | 3.038 |
| 20 | 45.5 | 30.9 | 14.6 | 3.38 | 3.085 |
| 21 | 45.5 | 30.9 | 14.6 | 3.40 | 3.105 |
| 22 | 55.7 | 31.0 | 24.7 | 5.40 | 4.940 |
| 23 | 55.0 | 30.5 | 24.5 | 5.37 | 4.900 |
| 24 | 62.0 | 30.6 | 31.4 | 6.72 | 6.135 |
| 25 | 61.6 | 30.0 | 31.6 | 6.70 | 6.120 |
| 26 | 33.1 | 29.3 | 3.8 | 1.02 | .932 |
| 27 | 33.0 | 29.3 | 3.7 | 1.00 | .913 |
| 28 | 46.5 | 29.7 | 16.8 | 3.68 | 3.360 |
| 29 | 46.3 | 29.7 | 16.6 | 3.70 | 3.380 |
| 30 | 42.0 | 29.7 | 12.3 | 2.85 | 2.600 |
| 31 | 41.4 | 29.7 | 11.7 | 2.73 | 2.493 |
| 32 | 40.5 | 29.7 | 10.8 | 2.62 | 2.390 |

*Note: Column 6. L', the dynamometer lever arm, is 32 cm. long

$$2\ F'L'_{(Kg.M.)} = F'_{(Lbs.)} \times 2 \times 454\ g/lb. \times 32\ cm. \times 10^{-5}$$

Examination of this plot shows it to be approximately linear. The equation of the best fitting line to this series of points is

$$W = 0.182\ h. + 0.38$$

where W = work per revolution in Kg.m., and h. = height of polygraph curve in mm. From this equation it is possible to compute the amount of work done from the polygraph record which shows the tension on the drum (height of curve H, Fig. 5) and the number of revolutions as well as the duration of the exercise. Change in the tension which may result from rise in temperature of the brake drum will be recorded by changes in the height of the polygraph curve so that an accurate record of work done is obtained.

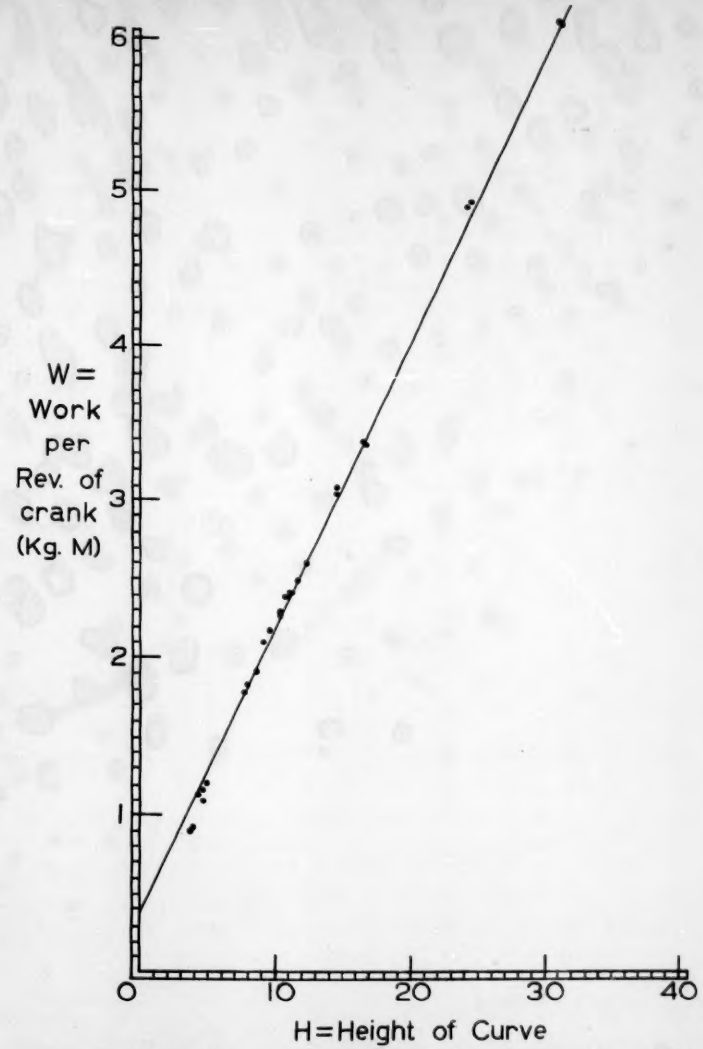


Fig. 7. Calibration curve of ergometer, showing experimental determination of work required per revolution of the pedal arm at increasing tensions on the friction drum as measured by increasing height of curve from sylphon tambours recorded on polygraph roll (distance from G to H in mm. on Figure 5). Best fitting equation to the line shown is Work per revolution of crank (Kg. m.) = 0.182 H + 0.38, where H is the height of the polygraph curve in mm.

## EXPERIMENTAL RESULTS OBTAINED

Tests were run on a group of 50 girls and 50 boys at six-month intervals between the ages of 13 and 17 years, in connection with the Adolescent Study at the Institute of Child Welfare.

Figure 8 shows the results obtained in a single exercise experiment obtained with the apparatus described. The curve for oxygen consumption is plotted in terms of cc. $O_2$ taken up per minute per kg. body weight and also as percentage deviation from the basal level determined before the start of exercise. Curves for pulse rate, blood pressure, and respiratory volume are also shown. In this experiment the period of increasing oxygen uptake at the beginning of the exercise is shown as well as the period of recovery. A study of age changes in recovery rate is being made from such data.

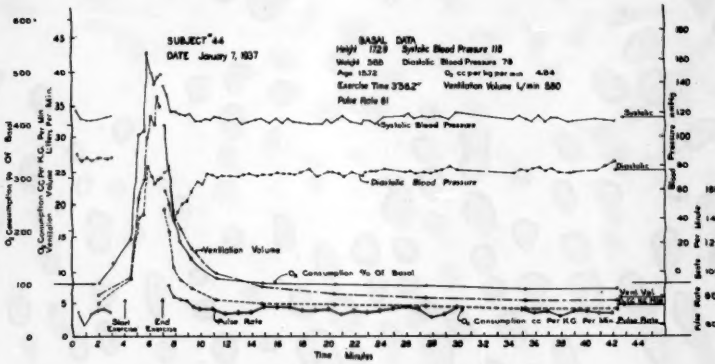


*Fig. 8. Sample plot of arm exercise experiments.*

Subject No. 44 - January 7, 1937.

Basal data: Height 172.9 cm.; Weight 56.8 kg.; Age 15.72 years; Systolic blood pressure 116 mm. Hg.; Diastolic blood pressure 76 mm. Hg.; Pulse rate 61 per minute; Basal $O_2$ consumption 4.84 cc. $O_2$ per kg. per minute; Ventilation volume 5.80 liters per minute.

Time of exercise - 3' 56.2"
Total work done - 992.6 kg. m.
Rate of work - 251 kg. m. per minute

Curves show:

- Systolic blood pressure
- Diastolic blood pressure
- Oxygen consumption % of basal
- Ventilation volume L./min.
- Oxygen consumption - cc./kg./min.
- Pulse rate

Basal values plotted at arrows at right.
Curves show physiological displacements during and after exercise.

SUMMARY

An apparatus is described for obtaining continuous samples of expired air at rest or after exercise and for measuring respiratory volume.

An ergometer is described which can be used for the performance of variable measured amounts of arm work by a subject in the supine position.

A calibration curve for the ergometer is presented.

Sample records obtained with the apparatus are shown.

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# THE SCHOOL LUNCH AS A SUPPLEMENT TO THE HOME DIET OF GRADE SCHOOL CHILDREN[1]

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in co-operation with

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Interest is general in the possibility of improving the nutritional status of grade-school children by mid-day or mid-session feeding at school. For this reason, the study described in this report was conducted to find whether or not it might be possible to supplement the morning and evening home meals of representative children in different socio-economic groups in such a way as to bring the day's intake up to a desirable standard.

The problem was undertaken in the following manner:

(1) A series of nutrition tests was given to each of 225 children representing a wide range of family cash income; these tests included:
   (a) nutritional rating from a physical examination given by a pediatrician;
   (b) weight status;
   (c) skeletal status including a maturity assay and a mineralization index;
   (d) dental status;
   (e) slump;
   (f) plantar contact;
   (g) darkness adaptation response;
   (h) hemoglobin status; and
   (i) capillary wall strength.

(2) A one-week dietary was kept for each child.

(3) From the responses to the tests and the results of the dietary calculations, recommendations are made concerning the kind and amount of nutrient factors which should be included in the diets given at school to children of different socio-economic groups, so as to supplement the morning and evening meals likely to be received at home.

[1] *A joint contribution from The Pennsylvania State College and the Department of Health of the Commonwealth of Pennsylvania.*
*Authorized August 29, 1940 as Paper Number 6 in the Human Nutrition Research Series of the Division of Home Economics Research, The Pennsylvania State College.*
*The authors are indebted to Sophronia R. House for invaluable aid in tabulating data.*

[2] *From The Pennsylvania State College.*
[3] *Secretary of Health, The Commonwealth of Pennsylvania.*
[4] *Director of the Bureau of Maternal and Child Health, The Commonwealth of Pennsylvania.*

## METHODS OF PROCEDURE

### SUBJECTS OF THE STUDY

For the study, 225 children, including 102 males and 123 females, were selected from two non-metropolitan urban communities in which children were being tested for nutritional status and dietary habits in connection with a long-time program of research carried on jointly by the Department of Health of the Commonwealth of Pennsylvania and the Division of Home Economics Research at The Pennsylvania State College. The children for this aspect of the larger nutritional study were chosen from the two communities in such a way as to represent the family cash income distribution of the school children in the combined communities as a whole. On the basis of cash income, following the arbitrary income grouping described by Mack and Smith (8), the children in the present study were distributed as follows:

31 in Income Classes A and B combined, representing families with annual cash incomes of $2500 and above;
101 in Income Class C, representing families with incomes of $2499 to $1000;
56 in Income Class D, representing families with incomes below $1000 but not on direct governmental relief; and
37 from families which were on direct governmental relief at the time when the measurements were made.

Although the basis for the selection of the children for this investigation was family annual cash income, the education of the adults in the families, as well as a rating of their physical homes were obtained from home visits by registered nurses associated with the study, and the responses of the children to the nutritional tests as well as their intake of the various nutrients were averaged on the basis of family education and of physical home rating, as well as of family cash income. The rating schemes for family cash income, family education, and physical home score were those described by Mack and Smith (8), as follows:

"Family cash income is rated according to an arbitrary scale as follows:

Class A-1, $10,000 or above
A-2, 7,500 to 9,999, inclusive
A-3, 5,000 to 7,499, inclusive

Class B-1, 4,000 to 4,999, inclusive
B-2, 3,000 to 3,999, inclusive
B-3, 2,500 to 2,999, inclusive

Class C-1, 2,000 to 2,499, inclusive
C-2, 1,500 to 1,999, inclusive
C-3, 1,000 to 1,499, inclusive

Class D, Incomes below $1,000.00, exclusive of families on direct relief.

Class E, Income of families on direct relief alone."

"The educational level of a family is rated arbitrarily according to the education of adult members, which are defined to include all persons of 19 years of age or over, except those who are still continuing their education. The rating scale is as follows:

Class A, All adults college graduates;
Class B, One member of the family a college graduate;
Class C, All adults high school graduates;
Class D, One member of the family a high school graduate;
Class E, No member of the family a high school graduate."

"In devising an arbitrary 100-point system for grading a home as to its physical characteristics, the home was regarded as a place in which the family eats and sleeps, and in which there should be adequate provision for rest, recreation, the preparation and consumption of food, and group social life. The rating system used was intended to give credit to those features in the home which are believed to influence the general well-being of the family members, particularly as regards nutritional status. The data sheet used in making physical home evaluations is the following:

SIZE OF HOUSE: (Number of Rooms ___) - 12 points . . . . . ___
(Note whether or not there are roomers, and how many) ___

FURNITURE:
10 points for entirely adequate furniture (in good condition) for the size of the house; number of points adjusted downward at discretion of grader; 6 points is the maximum to be given if furniture is adequate, but not in good condition . . . . . ___

CLEANLINESS OF INTERIOR:
10 points if interior is immaculate in every detail; number of points to be adjusted downward at the discretion of the grader . . . . . ___

POSSESSION OF A CENTRAL HEATING PLANT: - Maximum 10 points ___

POSSESSION OF CONVENIENT COOKING EQUIPMENT: - Maximum 5 points. . . . . ___

POSSESSION OF SATISFACTORY REFRIGERATOR: - Maximum 5 points ___

POSSESSION OF A WORTHWHILE MUSICAL INSTRUMENT: - Maximum 5 points. . . . . ___

ORNAMENTATION WITHIN THE HOUSE: - Maximum 5 points . . . . ___

PROVISION FOR REST:
For Child - Sleeps alone - 8 points . . . . . ___
Sleeps with one other child - 7 points . . . . . ___
Sleeps with one adult - 6 points . . . . . ___
Sleeps with two other children - 4 points . . . . . ___
Sleeps with two adults, or three other children - 1 point . . . . . ___
For Adult - Maximum 8 points, depending upon adequacy of provision for rest . . . . . ___

(Note: Each individual is rated, and the average taken as the rating of the home on this point.)

Average . . . . . ___

EXTERIOR OF HOUSE WELL KEPT: - Maximum 10 points . . . . . ___

PROVISION FOR RECREATION: - Maximum 10 points . . . . . ___

POSSESSION OF GRASS AND FLOWERS: - Maximum 5 points . . . . ___

POSSESSION OF VEGETABLE GARDEN: - Maximum 5 points. . . . . ___

TOTAL POINTS _____

RATING OF PHYSICAL HOME: _____"

### TIME OF STUDY

The nutritional measurements were made and the dietary records were kept in 1938 and 1939, and the data were analyzed during 1939 and 1940.

### NUTRITIONAL MEASUREMENTS

The tests given to the children, which have been described in detail by Mack and Smith (8), were the following:

#### Ratings for Nutritional Status by Physical Examination

A physical examination is one of the earliest methods of determining the nutritional status of an individual when given by a skilled pediatrician. This rating presents general evidence of the nutritional well-being of a person as judged by the condition of the skin, pallor, posture, musculature, skeletal firmness, and evidence of the presence or absence of fatigue. The method is highly subjective, however, and is believed to be more valuable when used in connection with more objective tests. In this examination, the maximum possible score is 100 points.

#### Measurements of Body Build

Body build measurements have been included in almost all reported studies on nutritional status. In this study, the Pryor scale involving height, iliac width, and weight standards for children of the two sexes was used, to find how closely the weights of the children compared with the respective accepted standard weights of children of the same age, sex, height, and iliac width.

#### Determination of Skeletal Status

Roentgenograms offer a means of determining the skeletal maturity and skeletal mineralization in children. In judging maturity the roentgenograms of hand and knee were compared with standards developed by the late T. Wingate Todd of Western Reserve University. By this method, chronological age and skeletal maturation age were compared with each other, and the difference was recorded.

Mineral density indices were obtained by the photoelectric microphotometric method in use in this laboratory, and a mineral index was calculated for each subject in the study.

### Dental Status

The incidence and extent of dental caries were determined by a clinical examination made for each child by a Doctor of Dental Surgery. The results of this examination, together with complete mouth roentgenograms, made it possible to assign a dental rating score to each child. The score ranged from one to 10, with one the lowest and 10 the highest possible score.

### Calculation of Slump

Two indices were calculated as slump values; the former, called standing slump, is the percentage loss in height when changing from a horizontal to a standing position, and the latter, called sitting slump, is the percentage loss in changing from a stem end to a sitting height position.

### Measurements of Plantar Contact

Some investigators believe that there is a relationship between the plantar contact of a human being and nutritional status, although this relationship has not yet been definitely established. In this study, the ratio of the area of plantar contact while standing to that while sitting, as well as the average percentage of the sole of the foot touching while the subject was sitting were calculated as two separate indices.

### Hemoglobin Status

The standard Newcomer Method was used to determine the amount of hemoglobin in the blood in terms of grams per hundred c.c. of blood. By this method hematin is measured against a color plate.

### Biophotometer

The Biophotometer was used in the examination of each of the subjects. This test was based on the established fact that retarded dark adaptation is associated with vitamin A deficiency. The subjects were tested by the method described by Jeans and his associates (4) and by Mack and Smith (8). Calculations of data were made for each subject for each of the five indices designated by Mack and Smith as the bright light, dark regeneration, total integration, bleaching integration, and darkness integration index.

### Capillary Wall Strength

Capillary wall strength was measured by the method of Dalldorf (1), as modified by Logan (5). This test is believed to be associated with

general nutritional status, although it is not a specific test for vitamin C as was originally believed. In the Pennsylvania child nutrition studies of which this is a part, blood ascorbic acid tests have recently been introduced. The method for making these tests on micro samples of blood in mass studies, as recommended by McCormick (6) was not yet developed to the point of use with large numbers of subjects until near the close of this study.

Method of Assigning Classes of Response to Nutritional Tests

For grouping the responses of the various children to the nutritional tests, the following arbitrary classifications were used:

Nutritional Status by Physical Examination

| | |
|---|---|
| Class 1 | 100 - 85 points |
| Class 2 | 84 - 70 points |
| Class 3 | 69 - 55 points |
| Class 4 | 54 - 40 points |
| Class 5 | 39 and below |

Weight Status by Pryor Standards

| | |
|---|---|
| Class 1 | Standard ± 10 |
| Class 2a | 11 - 15% underweight |
| Class 2b | 11 - 15% overweight |
| Class 3a | 16 - 20% underweight |
| Class 3b | 16 - 20% overweight |
| Class 4a | 21 - 25% underweight |
| Class 4b | 21 - 25% overweight |
| Class 5a | 26% and more underweight |
| Class 5b | 26% and more overweight |

Skeletal Status (Skeletal Maturity as Measured by the Todd Standards)*

| | |
|---|---|
| Class 1 | Same as chronological age and above, or 6 months retarded |
| Class 2 | 6.1 - 9 months retarded |
| Class 3 | 9.1 - 12 months retarded |
| Class 4 | 12.1 - 18 Months retarded |
| Class 5 | Retarded 18.1 months and over |

Dental Rating

| | |
|---|---|
| Class 1 | 9 to 10 points |
| Class 2 | 7 to 8 points |
| Class 3 | 5 to 6 points |
| Class 4 | 3 to 4 points |
| Class 5 | Below 3 points |

*Skeletal mineralization classes are those of this laboratory, as yet unpublished.

### Slump Standing

Percentage Slump in Standing or Sitting:

$$\frac{\text{Horizontal Height} - \text{Standing Height}}{\text{Horizontal Height}} \times 100 = \text{Slump (Standing)}$$

$$\frac{\text{Stem End} - \text{Sitting Height}}{\text{Stem End}} \times 100 = \text{Slump (Sitting)}$$

| | |
|---|---|
| Class 1 | 0 to 1.99 |
| Class 2 | 2 to 3.99 |
| Class 3 | 4 to 5.99 |
| Class 4 | 6 to 7.99 |
| Class 5 | 8 to 10 |

### Plantar Contact

a. Plantar Contact Standing/Sitting Ratio:

| | |
|---|---|
| Class 1 | 1.09 and under |
| Class 2 | 1.10 to 1.14 |
| Class 3 | 1.15 to 1.19 |
| Class 4 | 1.20 to 1.24 |
| Class 5 | 1.25 and over |

b. Plantar Contact Average Percentage of Sitting Feet Touching:

| | |
|---|---|
| Class 1 | 0 to 69.99 |
| Class 2 | 70 to 77.99 |
| Class 3 | 78 to 85.99 |
| Class 4 | 86 to 92.99 |
| Class 5 | 93 to 100 |

### Hemoglobin

| | |
|---|---|
| Class 1 | 13.0 and above g./100 c.c. blood |
| Class 2 | 12.99 to 11.5 |
| Class 3 | 11.49 to 10.0 |
| Class 4 | 9.99 to 7.5 |
| Class 5 | 7.49 and below |

### Biophotometer (Bright Light Factor)[5]

| | |
|---|---|
| Class 1 | 0.00 to 0.30 millifoot candles |
| Class 2 | 0.31 to 0.60 millifoot candles |
| Class 3 | 0.61 to 1.09 millifoot candles |
| Class 4 | 1.10 to 3.59 millifoot candles |
| Class 5 | 3.60 and above |

### Biophotometer (Total Integration Factor)[6]

| | |
|---|---|
| Class 1 | Under 1 |
| Class 2 | From 1.00 to 2.50 |

[5] *Millifoot candles required to reach end point during test immediately following bleaching.*
[6] *Area under entire biophotometer curve made in manner described by Hack and Smith, (8).*

Class 3 . . . . . From 2.51 to 3.00
Class 4 . . . . . From 3.01 to 5.00
Class 5 . . . . . Over 5.00

Capillary Wall Strength

Class 1 . . . . . No break at 55 or 60 cm. 1+ break at 55 or 60 cm.
Class 2 . . . . . 2+ or 3+ break at 50, 55, or 60 cm.
Class 3 . . . . . 4+ break at 50, 55, or 60 cm.
Class 4 . . . . . 3+ or 4+ break at 40 or 45 cm.
Class 5 . . . . . 4+ break at 30 or 45 cm.

Method of Obtaining and Calculating Dietaries

At least two visits were paid to the home of each child in the one-week period during which dietary records were being kept for the child. Adults in the family were instructed in the recording of sizes of portions of food consumed by the child, and the child was instructed concerning the importance of reporting all food eaten between meals. Any food eaten in the morning was added to breakfast in calculating the dietaries, and anything eaten in the afternoon or evening was added to the evening meal.

The average intakes of energy, protein, calcium, phosphorus, iron, vitamin A (International Units), vitamin $B_1$ (International Units), vitamin C (Milligrams), and riboflavin (Milligrams), were calculated from recent food value tables as found in the following references:

The Chemistry of Food and Nutrition, Henry C. Sherman, Fifth Edition, 1937, The Macmillan Company.

A Laboratory Handbook for Dietetics, Mary Swartz Rose, Fourth Edition, 1937, The Macmillan Company.

The Newer Knowledge of Nutrition, Elmer V. McCollum, Elsa Orent Keiles and Harry G. Day, Fifth Edition, 1939, The Macmillan Company.

The Nutritive Value of Fruits, Vegetables and Nuts, R. A. McCance, E. M. Widdowson and L. R. B. Shackleton, Special Report Series No. 213, 1936, Medical Research Council, London.

Chemical Composition of Foods, R. A. McCance and E. M. Widdowson, Medical Research Council, London, 1940.

Tables of the Vitamin Content of Human and Animal Foods, Margaret A. Boas Fixsen and Margaret H. Roscoe, Nutrition Abstracts and Reviews 7:823-867 (1937-1938).

Vitamin Content of Foods, Esther P. Daniel and Hazel E. Munsell, 1937, Miscellaneous Publication 275, United States Department of Agriculture.

The Vitamin $B_1$ (thiamin) Assay Value of Foods, Lela E. Booher and Eva R. Hartzler, 1939, Technical Bulletin 707, United States Department of Agriculture (Now in Press).

The Distribution of Vitamin $B_1$ (thiamin) in Meat and Meat Products, Olaf Mickelsen, Harry A. Waisman and C. A. Elvhjem, The Journal of Nutrition 17: 269-281, March 10, 1939.

Vitamin $B_1$ and Its Use in Medicine, Robert R. Williams and Tom D. Spies, 1938, The Macmillan Company.

### Method of Assigning Unit Equivalent Values to Children on Basis of Various Nutrients

Unit equivalent values were assigned to all children by referring to the Bureau of Home Economics Standards as described by Stiebeling and Phipard (10). The nutrients - energy, protein, calcium, phosphorus, iron, vitamin A, vitamin $B_1$, vitamin C, and riboflavin of various individuals were related to those required by a 70-kilogram man of average size and moderate activity. By this method it is possible to obtain the approximate requirement of the individual in relation to that of a unit man, and thus resolve a heterogeneous group of people to a somewhat comparable basis. Table 1, taken from the Bureau of Home Economics values, shows the unit values used for the age groups of children in the table.

TABLE 1

NUTRIENT REQUIREMENT UNITS ASSIGNED TO INDIVIDUAL CHILDREN ON THE BASIS OF SEX AND AGE

| Sex | Age | Energy Factor | Protein Factor | Calcium Factor | Phosphorus Factor | Iron Factor | Vitamin Factors | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | A | $B_1$ | C | Ribo-flavin |
| Male | 4- 6 | 0.50 | 0.80 | 1.5 | 0.8 | 0.5 | 0.75 | 0.40 | 0.70 | 0.75 |
| Male | 7- 8 | 0.70 | 1.00 | 1.5 | 0.8 | 0.7 | 0.90 | 0.70 | 0.70 | 0.90 |
| Male | 9-10 | 0.80 | 1.10 | 1.5 | 0.9 | 0.8 | 0.90 | 0.80 | 0.80 | 0.90 |
| Male | 11-12 | 0.83 | 1.10 | 1.5 | 0.9 | 0.9 | 1.00 | 0.83 | 0.90 | 1.00 |
| Male | 13-15 | 1.00 | 1.10 | 1.5 | 1.0 | 1.0 | 1.00 | 1.00 | 1.00 | 1.00 |
| Male | 16-19 | 1.20 | 1.10 | 1.5 | 1.0 | 1.0 | 1.00 | 1.20 | 1.20 | 1.00 |
| Female | 4- 7 | 0.50 | 0.80 | 1.5 | 0.8 | 0.5 | 0.75 | 0.50 | 0.70 | 0.75 |
| Female | 8-10 | 0.70 | 1.00 | 1.5 | 0.8 | 0.7 | 0.90 | 0.70 | 0.70 | 0.90 |
| Female | 11-13 | 0.80 | 1.10 | 1.5 | 0.9 | 0.8 | 0.90 | 0.80 | 0.80 | 0.90 |
| Female | 14-19 | 0.83 | 1.10 | 1.5 | 0.9 | 0.9 | 1.00 | 0.83 | 0.90 | 1.00 |

## RESULTS OF THE STUDY

### RESPONSES TO NUTRITION TESTS

The average responses to the various nutrition tests of the children, grouped according to income, are shown in Table 2, Parts A to C. The average responses to these tests when grouped according to family education are shown in Table 3, Parts A to C. Their average responses when they were grouped on the basis of physical home rating are shown in Table 4, Parts A to C.

### Annual Family Income and Nutritional Status of Children

The average responses of the children to the various nutritional status tests are shown in Figure 1, left. The percentage distributions of the children in the different Income Groups, with respect to their responses to various of the nutritional status tests, are shown also in Figure 1, at the right.

Nutritional Rating by Physical Examination. The average score of all of the children of both sexes and of all of the socio-economic groups was 78.97 points in nutritional status by physical examination; the

TABLE 2

AVERAGE RESPONSES TO NUTRITION TESTS BASED ON VARYING INCOME LEVELS

PART A

| Income Group | Sex | Number of Cases | Physical Examination Rating (Points) | Physical Examination Class | Distribution of Cases in Weight Classes According to Pryor Scale (Number of Cases): Class 1 (Correct Weight ±10%) | Under-Weight Class 2a | 3a | 4a | 5a | Over-Weight Class 2b | 3b | 4b | 5b | Dental Examination Rating (Points) | Dental Examination Class |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A and B | Male | 17 | 81.00 | 1.71 | 12 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 6.9 | 2.29 |
| | Female | 14 | 80.00 | 2.07 | 6 | 0 | 1 | 0 | 1 | 2 | 1 | 2 | 1 | 6.9 | 2.43 |
| | All Cases | 31 | 80.55 | 1.87 | 18 | 2 | 1 | 0 | 1 | 2 | 2 | 3 | 2 | 6.9 | 2.35 |
| C | Male | 46 | 78.74 | 1.98 | 32 | 4 | 0 | 0 | 1 | 7 | 0 | 3 | 0 | 6.8 | 2.28 |
| | Female | 55 | 79.51 | 1.82 | 29 | 2 | 0 | 0 | 1 | 8 | 11 | 2 | 2 | 6.2 | 2.69 |
| | All Cases | 101 | 79.14 | 1.89 | 61 | 6 | 0 | 0 | 0 | 15 | 11 | 5 | 2 | 6.4 | 2.43 |
| D | Male | 25 | 79.44 | 1.96 | 14 | 0 | 0 | 0 | 0 | 2 | 5 | 1 | 3 | 6.9 | 2.24 |
| | Female | 31 | 77.87 | 2.03 | 15 | 0 | 1 | 0 | 0 | 8 | 3 | 3 | 1 | 6.2 | 2.70 |
| | All Cases | 56 | 78.57 | 2.00 | 29 | 0 | 1 | 0 | 0 | 10 | 8 | 4 | 4 | 6.5 | 2.49 |
| E | Male | 14 | 76.93 | 2.07 | 9 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 6.9 | 2.29 |
| | Female | 23 | 78.70 | 2.04 | 15 | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 4 | 6.9 | 2.35 |
| | All Cases | 37 | 78.03 | 2.05 | 24 | 1 | 2 | 1 | 0 | 1 | 2 | 1 | 5 | 6.9 | 2.33 |
| All Children | Male | 102 | 79.04 | 1.94 | 67 | 7 | 1 | 1 | 0 | 10 | 6 | 5 | 5 | 6.9 | 2.27 |
| | Female | 123 | 78.92 | 1.94 | 65 | 2 | 3 | 0 | 2 | 18 | 17 | 8 | 8 | 6.4 | 2.54 |
| | All Cases | 225 | 78.97 | 1.94 | 132 | 9 | 4 | 1 | 2 | 28 | 23 | 13 | 13 | 6.5 | 2.42 |

PART B

| Income Group | Sex | Number of Cases | Skeletal Status (Class): Maturity by Todd Standards | Skeletal Status (Class): Mineral Density | Slump (Class): Standing | Slump (Class): Sitting | Plantar Contact Class: Standing Sitting Ratio | Plantar Contact Class: Average Sitting |
|---|---|---|---|---|---|---|---|---|
| A and B | Male | 17 | 1.38 | 2.94 | 1.35 | 3.47 | 2.94 | 1.59 |
| | Female | 14 | 1.71 | 3.07 | 1.07 | 1.79 | 1.57 | 1.64 |
| | All Cases | 31 | 1.51 | 3.00 | 1.22 | 2.71 | 2.32 | 1.61 |
| C | Male | 46 | 1.74 | 2.61 | 1.09 | 2.87 | 1.83 | 1.85 |
| | Female | 55 | 2.00 | 2.96 | 1.20 | 2.35 | 1.87 | 1.82 |
| | All Cases | 101 | 1.88 | 2.80 | 1.15 | 2.58 | 1.85 | 1.83 |
| D | Male | 25 | 1.50 | 3.12 | 1.04 | 2.32 | 2.25 | 1.80 |
| | Female | 31 | 2.29 | 3.45 | 1.10 | 1.65 | 1.35 | 2.00 |
| | All Cases | 56 | 1.94 | 3.30 | 1.07 | 1.96 | 1.75 | 1.91 |
| E | Male | 14 | 2.36 | 2.93 | 1.36 | 3.43 | 1.71 | 2.36 |
| | Female | 23 | 2.65 | 2.65 | 1.28 | 2.21 | 1.87 | 1.44 |
| | All Cases | 37 | 2.54 | 2.76 | 1.31 | 2.67 | 1.81 | 1.79 |
| All Children | Male | 102 | 1.70 | 2.83 | 1.16 | 2.91 | 2.19 | 1.86 |
| | Female | 123 | 2.16 | 3.02 | 1.17 | 2.16 | 1.71 | 1.77 |
| | All Cases | 225 | 1.95 | 2.93 | 1.17 | 2.49 | 1.93 | 1.81 |

PART C

| Income Group | Sex | Number of Cases | Biophotometer: Bright Light Factor | Biophotometer: Class | Calculated Factors for Biophotometer Response: Dark Regeneration | Calculated Factors for Biophotometer Response: Total Integration | Calculated Factors for Biophotometer Response: Bleach Integration | Calculated Factors for Biophotometer Response: Darkness Integration | Hemoglobin: Average (g./100 c.c. blood) | Hemoglobin: Class | Capillary Wall Strength (Class) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A and B | Male | 17 | 0.52 | 2.71 | 0.14 | 1.16 | 0.69 | 0.50 | 13.25 | 1.47 | 1.29 |
| | Female | 14 | 0.36 | 3.00 | 0.16 | 1.50 | 0.86 | 0.63 | 13.19 | 1.29 | 1.14 |
| | All Cases | 31 | 0.45 | 2.84 | 0.15 | 1.31 | 0.77 | 0.56 | 13.22 | 1.39 | 1.22 |
| C | Male | 46 | 1.00 | 3.13 | 0.21 | 1.75 | 1.02 | 1.75 | 13.25 | 1.48 | 1.20 |
| | Female | 55 | 1.09 | 3.04 | 0.27 | 2.05 | 1.13 | 0.91 | 13.20 | 1.45 | 1.16 |
| | All Cases | 101 | 1.05 | 3.08 | 0.24 | 1.91 | 1.08 | 1.29 | 13.22 | 1.46 | 1.18 |
| D | Male | 25 | 1.24 | 3.40 | 0.27 | 2.24 | 1.27 | 0.97 | 13.53 | 1.24 | 1.16 |
| | Female | 31 | 1.43 | 3.04 | 0.25 | 2.51 | 1.47 | 1.14 | 13.20 | 1.32 | 1.13 |
| | All Cases | 56 | 1.35 | 3.20 | 0.26 | 2.39 | 1.38 | 1.06 | 13.35 | 1.28 | 1.14 |
| E | Male | 14 | 1.12 | 3.00 | | 2.46 | 1.15 | 0.82 | 13.18 | 1.50 | 1.07 |
| | Female | 23 | 1.18 | 3.52 | | 2.74 | 1.16 | 1.05 | 13.06 | 1.52 | 1.09 |
| | All Cases | 37 | 1.16 | 3.32 | | 2.63 | 1.44 | 1.03 | 13.11 | 1.51 | 1.08 |
| All Children | Male | 102 | 1.01 | 3.11 | 0.22 | 1.80 | 1.04 | 0.77 | 13.30 | 1.42 | 1.09 |
| | Female | 123 | 1.24 | 3.24 | 0.11 | 2.09 | 1.27 | 0.96 | 13.22 | 1.41 | 1.14 |
| | All Cases | 225 | 1.14 | 3.18 | 0.16 | 1.96 | 1.17 | 0.87 | 13.26 | 1.41 | 1.12 |

TABLE 3

AVERAGE RESPONSES TO NUTRITION TESTS BASED ON VARYING EDUCATION LEVELS

PART A

| Income Group | Sex | Number of Cases | Physical Examination Rating (Points) | Physical Examination Class | Distribution of Cases in Weight Classes According to Pryor Scale (Number of Cases): Class 1 (Correct Weight ±10%) | Under-Weight Class 2a | 3a | 4a | 5a | Over-Weight Class 2b | 3b | 4b | 5b | Mental Examination Rating (Points) | Mental Examination Class |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | Male | 10 | 81.60 | 1.90 | 5 | 1 | 0 | 0 | 0 | 2 | 0 | 1 | | 6.9 | 2.40 |
| | Female | 7 | 77.29 | 2.00 | 4 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | | 6.4 | 2.71 |
| | All Cases | 17 | 79.83 | 1.94 | 9 | 1 | 1 | 0 | 0 | 3 | 1 | 1 | | 6.7 | 2.53 |
| B | Male | 14 | 76.64 | 1.64 | 10 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 7.8 | 1.79 |
| | Female | 10 | 81.70 | 1.80 | 4 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 0 | 7.3 | 2.30 |
| | All Cases | 24 | 78.75 | 1.71 | 14 | 1 | 0 | 0 | 1 | 1 | 3 | 3 | 1 | 7.6 | 2.00 |
| C | Male | 6 | 79.17 | 2.00 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7.3 | 2.00 |
| | Female | 2 | 79.00 | 2.00 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 7.0 | 2.00 |
| | All Cases | 8 | 79.13 | 2.00 | 5 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 7.2 | 2.00 |
| D | Male | 10 | 75.80 | 1.90 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7.0 | 2.20 |
| | Female | 19 | 80.27 | 1.71 | 8 | 1 | 0 | 0 | 0 | 2 | 3 | 2 | 3 | 6.4 | 2.53 |
| | All Cases | 29 | 78.62 | 1.78 | 18 | 1 | 0 | 0 | 0 | 2 | 3 | 2 | 3 | 6.6 | 2.42 |
| E | Male | 62 | 77.85 | 2.02 | 38 | 4 | 1 | 1 | 0 | 8 | 6 | 3 | 3 | 6.6 | 2.42 |
| | Female | 85 | 78.42 | 1.96 | 47 | 1 | 6 | 0 | 1 | 14 | 7 | 4 | 5 | 6.2 | 2.76 |
| | All Cases | 147 | 78.18 | 1.99 | 85 | 5 | 7 | 1 | 1 | 22 | 13 | 7 | 8 | 6.4 | 2.59 |
| All Children | Male | 102 | 79.04 | 1.94 | 67 | 7 | 1 | 1 | 0 | 10 | 6 | 5 | 5 | 6.9 | 2.27 |
| | Female | 123 | 78.92 | 1.94 | 65 | 2 | 3 | 0 | 2 | 18 | 17 | 8 | 8 | 6.4 | 2.54 |
| | All Cases | 225 | 78.97 | 1.94 | 132 | 9 | 4 | 1 | 2 | 28 | 23 | 13 | 13 | 6.6 | 2.42 |

PART B

| Income Group | Sex | Number of Cases | Skeletal Status (Class): Maturity by Todd Standards | Skeletal Status (Class): Mineral Density | Slump (Class): Standing | Slump (Class): Sitting | Plantar Contact Class: Standing Sitting Ratio | Plantar Contact Class: Average Sitting |
|---|---|---|---|---|---|---|---|---|
| A | Male | 10 | 1.00 | 3.00 | 1.20 | 3.20 | 3.10 | 1.50 |
| | Female | 7 | 2.27 | 4.00 | 1.14 | 3.86 | 3.29 | 1.29 |
| | All Cases | 17 | 1.52 | 3.41 | 1.17 | 3.47 | 3.18 | 1.41 |
| B | Male | 14 | 1.07 | 2.36 | 1.57 | 2.50 | 2.21 | 1.57 |
| | Female | 10 | 1.80 | 2.90 | 1.20 | 3.10 | 1.50 | 1.60 |
| | All Cases | 24 | 1.37 | 2.59 | 1.42 | 2.75 | 1.91 | 1.58 |
| C | Male | 6 | 2.67 | 3.17 | 1.00 | 3.50 | 3.33 | 2.17 |
| | Female | 2 | 5.00 | 4.00 | 1.00 | 3.50 | 1.50 | 2.50 |
| | All Cases | 8 | 3.25 | 3.38 | 1.00 | 3.50 | 2.87 | 2.25 |
| D | Male | 10 | 2.30 | 2.90 | 1.10 | 2.78 | 2.60 | 1.90 |
| | Female | 19 | 1.78 | 2.73 | 1.16 | 3.63 | 2.16 | 1.84 |
| | All Cases | 29 | 1.96 | 2.79 | 1.14 | 3.34 | 2.31 | 1.86 |
| E | Male | 62 | 1.76 | 2.87 | 1.13 | 2.85 | 1.79 | 1.96 |
| | Female | 85 | 2.16 | 3.00 | 1.16 | 3.35 | 2.04 | 1.82 |
| | All Cases | 147 | 1.99 | 2.95 | 1.15 | 3.14 | 1.93 | 1.87 |
| All Children | Male | 102 | 1.70 | 2.83 | 1.16 | 2.91 | 2.19 | 1.86 |
| | Female | 123 | 2.16 | 3.02 | 1.17 | 2.16 | 1.70 | 1.77 |
| | All Cases | 225 | 1.95 | 2.93 | 1.17 | 2.50 | 1.92 | 1.81 |

PART C

| Income Group | Sex | Number of Cases | Biophotometer: Bright Light Factor | Biophotometer: Class | Calculated Factors for Biophotometer Response: Dark Regeneration | Calculated Factors for Biophotometer Response: Total Integration | Calculated Factors for Biophotometer Response: Bleach Integration | Calculated Factors for Biophotometer Response: Darkness Integration | Hemoglobin: Average (g./100 c.c. blood) | Hemoglobin: Class | Capillary Wall Strength (Class) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A | Male | 10 | 0.68 | 2.80 | 0.16 | 1.31 | 0.69 | 0.67 | 13.07 | 1.50 | 1.40 |
| | Female | 7 | 0.63 | 3.00 | 0.19 | 1.39 | 0.81 | 0.58 | 12.90 | 1.43 | 1.14 |
| | All Cases | 17 | 0.66 | 2.88 | 0.17 | 1.34 | 0.74 | 0.57 | 13.00 | 1.47 | 1.29 |
| B | Male | 14 | 0.65 | 2.86 | 0.17 | 1.14 | 0.66 | 0.49 | 13.11 | 1.57 | 1.07 |
| | Female | 10 | 1.15 | 3.60 | 0.33 | 2.76 | 1.48 | 1.28 | 13.66 | 1.10 | 1.20 |
| | All Cases | 24 | 0.86 | 3.17 | 0.24 | 1.82 | 1.01 | 0.82 | 13.34 | 1.37 | 1.12 |
| C | Male | 6 | 1.03 | 3.33 | 0.30 | 2.16 | 1.16 | 0.87 | 14.34 | 1.17 | 1.17 |
| | Female | 2 | 0.43 | 2.00 | 0.02 | 0.81 | 0.45 | 0.46 | 13.22 | 1.00 | 1.00 |
| | All Cases | 8 | 0.88 | 3.00 | 0.23 | 1.85 | 0.98 | 0.77 | 14.08 | 1.13 | 1.13 |
| D | Male | 10 | 1.12 | 3.30 | 0.14 | 2.13 | 1.03 | 0.83 | 13.60 | 1.40 | 1.20 |
| | Female | 19 | 1.24 | 3.05 | 0.60 | 2.61 | 1.43 | 1.08 | 13.01 | 1.47 | 1.17 |
| | All Cases | 29 | 1.20 | 3.14 | 0.44 | 2.38 | 1.29 | 0.94 | 13.21 | 1.45 | 1.18 |
| E | Male | 62 | 1.11 | 3.13 | 0.23 | 1.99 | 1.17 | 0.84 | 13.94 | 1.40 | 1.15 |
| | Female | 85 | 1.26 | 3.26 | 0.29 | 2.24 | 1.26 | 0.99 | 13.94 | 1.46 | 1.12 |
| | All Cases | 147 | 1.19 | 3.21 | 0.26 | 2.13 | 1.22 | 0.93 | 13.94 | 1.43 | 1.13 |
| All Children | Male | 102 | 1.01 | 3.11 | 0.22 | 1.81 | 1.04 | 0.77 | 13.30 | 1.42 | 1.09 |
| | Female | 123 | 1.24 | 3.24 | 0.11 | 2.09 | 1.27 | 0.96 | 13.22 | 1.41 | 1.14 |
| | All Cases | 225 | 1.14 | 3.18 | 0.16 | 1.96 | 1.17 | 0.87 | 13.26 | 1.41 | 1.12 |

TABLE 4

AVERAGE RESPONSES TO NUTRITION TESTS BASED ON VARYING PHYSICAL HOME LEVELS

PART A

| Income Groups | Sex | Number of Cases | Physical Examination Rating (Points) | Physical Examination Class | Distribution of Cases in Weight Classes According to Pryor Scale (Number of Cases) Class 1 (Correct Weight ±10%) | Under-Weight Class 2a | 3a | 4a | 5a | Over-Weight Class 2b | 3b | 4b | 5b | Dental Examination Rating (Points) | Dental Examination Class |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | Male | 53 | 80.0 0 | 1.85 | 34 | 4 | 0 | 1 | 0 | 5 | 2 | 1 | 3 | 7.1 | 2.18 |
| | Female | 50 | 88.68 | 1.70 | 22 | 2 | 2 | 0 | 1 | 8 | 9 | 0 | 2 | 6.4 | 2.58 |
| | All Cases | 103 | 84.21 | 1.78 | 56 | 6 | 2 | 1 | 1 | 13 | 11 | 1 | 5 | 6.8 | 2.37 |
| B | Male | 33 | 78.30 | 2.03 | 21 | 2 | 0 | 0 | 0 | 4 | 4 | 0 | 0 | 6.2 | 2.45 |
| | Female | 39 | 78.52 | 1.92 | 24 | 0 | 1 | 0 | 1 | 6 | 2 | 0 | 2 | 6.3 | 2.46 |
| | All Cases | 72 | 78.42 | 1.97 | 45 | 2 | 1 | 0 | 1 | 10 | 6 | 0 | 2 | 6.3 | 2.46 |
| C | Male | 12 | 76.67 | 2.08 | 9 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 6.7 | 2.41 |
| | Female | 29 | 79.72 | 2.00 | 18 | 0 | 0 | 0 | 0 | 3 | 5 | 0 | 2 | 6.4 | 2.55 |
| | All Cases | 41 | 78.83 | 2.02 | 27 | 0 | 1 | 0 | 0 | 4 | 5 | 0 | 3 | 6.5 | 2.51 |
| D | Male | 4 | 79.75 | 2.00 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7.5 | 2.00 |
| | Female | 5 | 77.80 | 2.00 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 7.2 | 2.00 |
| | All Cases | 9 | 78.67 | 2.00 | 4 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 3 | 7.4 | 2.00 |
| E | Male | 0 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | Female | 0 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | All Cases | 0 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| All Children | Male | 102 | 79.04 | 1.94 | 67 | 7 | 1 | 1 | 0 | 10 | 6 | 1 | 5 | 6.9 | 2.27 |
| | Female | 123 | 78.92 | 1.94 | 65 | 2 | 3 | 0 | 2 | 18 | 17 | 0 | 8 | 6.4 | 2.54 |
| | All Cases | 225 | 78.97 | 1.94 | 132 | 9 | 4 | 1 | 2 | 28 | 23 | 1 | 13 | 6.6 | 2.42 |

PART B

| Income Group | Sex | Number of Cases | Skeletal Status (Class) Maturity by Todd Standards | Skeletal Status (Class) Mineral Density | Slump (Class) Standing | Slump (Class) Sitting | Plaster Contact Class Standing/Sitting Ratio | Plaster Contact Class Average Sitting |
|---|---|---|---|---|---|---|---|---|
| A | Male | 53 | 1.40 | 2.85 | 1.25 | 3.09 | 2.32 | 1.18 |
| | Female | 50 | 1.83 | 3.02 | 1.18 | 3.16 | 2.06 | 1.61 |
| | All Cases | 103 | 1.61 | 2.93 | 1.22 | 3.12 | 2.19 | 1.39 |
| B | Male | 33 | 2.03 | 2.88 | 1.18 | 2.48 | 2.00 | 1.85 |
| | Female | 39 | 2.34 | 3.33 | 1.16 | 3.36 | 2.10 | 1.92 |
| | All Cases | 72 | 2.20 | 3.12 | 1.17 | 2.96 | 2.05 | 1.90 |
| C | Male | 12 | 1.92 | 3.00 | 1.08 | 2.83 | 2.50 | 1.67 |
| | Female | 29 | 2.21 | 2.69 | 1.17 | 3.20 | 1.13 | 1.64 |
| | All Cases | 41 | 2.13 | 2.78 | 1.14 | 3.09 | 1.53 | 1.65 |
| D | Male | 4 | 2.25 | 1.75 | 1.50 | 4.25 | 1.25 | 3.00 |
| | Female | 5 | 3.40 | 2.40 | 1.20 | 3.20 | 1.80 | 1.80 |
| | All Cases | 9 | 2.89 | 2.11 | 1.33 | 3.67 | 1.56 | 2.33 |
| E | Male | 0 | - | - | - | - | - | - |
| | Female | 0 | - | - | - | - | - | - |
| | All Cases | 0 | - | - | - | - | - | - |
| All Children | Male | 102 | 1.70 | 2.83 | 1.16 | 2.91 | 2.19 | 1.86 |
| | Female | 123 | 2.16 | 3.02 | 1.17 | 2.16 | 1.71 | 1.77 |
| | All Cases | 225 | 1.95 | 2.93 | 1.17 | 2.50 | 1.93 | 1.81 |

PART C

| Income Group | Sex | Number of Cases | Biophotometer Bright Light Factor | Biophotometer Class | Calculated Factors for Biophotometer Response Dark Regeneration | Total Integration | Bleach Integration | Darkness Integration | Hemoglobin Average (g./100 c.c. blood) | Class | Capillary Wall Strength (Class) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A | Male | 53 | 0.83 | 2.94 | 0.21 | 1.54 | 0.86 | 0.75 | 13.24 | 1.43 | 1.17 |
| | Female | 50 | 1.19 | 3.01 | 0.24 | 1.77 | 1.05 | 0.81 | 13.38 | 1.34 | 1.80 |
| | All Cases | 103 | 1.00 | 2.97 | 0.22 | 1.65 | 0.95 | 0.78 | 13.28 | 1.39 | 1.48 |
| B | Male | 33 | 1.19 | 3.33 | 0.22 | 2.06 | 1.21 | 1.85 | 13.42 | 1.39 | 1.09 |
| | Female | 39 | 1.35 | 3.52 | 0.24 | 2.52 | 1.21 | 1.01 | 13.24 | 1.35 | 1.13 |
| | All Cases | 72 | 1.28 | 3.43 | 0.23 | 2.31 | 1.21 | 1.40 | 13.31 | 1.37 | 1.11 |
| C | Male | 12 | 1.51 | 3.50 | 0.20 | 2.06 | 1.54 | 1.01 | 12.75 | 1.50 | 1.16 |
| | Female | 29 | 1.12 | 3.28 | 0.30 | 2.75 | 1.29 | 1.19 | 13.02 | 1.59 | 1.14 |
| | All Cases | 41 | 1.23 | 3.34 | 0.27 | 2.55 | 1.36 | 1.14 | 12.94 | 1.56 | 1.15 |
| D | Male | 4 | 0.48 | 1.75 | 0.02 | 0.95 | 0.50 | 0.48 | 13.26 | 1.20 | 0.75 |
| | Female | 5 | 0.92 | 2.80 | 0.35 | 1.72 | 0.95 | 0.77 | 12.47 | 1.80 | 1.00 |
| | All Cases | 9 | 0.72 | 2.33 | 0.20 | 1.38 | 0.75 | 0.64 | 12.83 | 1.53 | 0.89 |
| E | Male | 0 | - | - | - | - | - | - | - | - | - |
| | Female | 0 | - | - | - | - | - | - | - | - | - |
| | All Cases | 0 | - | - | - | - | - | - | - | - | - |
| All Children | Male | 102 | 1.01 | 3.11 | 0.22 | 1.81 | 1.04 | 0.77 | 13.30 | 1.42 | 1.09 |
| | Female | 123 | 1.24 | 3.24 | 0.11 | 2.01 | 1.27 | 0.96 | 13.22 | 1.41 | 1.14 |
| | All Cases | 225 | 1.14 | 3.18 | 0.16 | 1.92 | 1.17 | 0.87 | 13.29 | 1.41 | 1.12 |

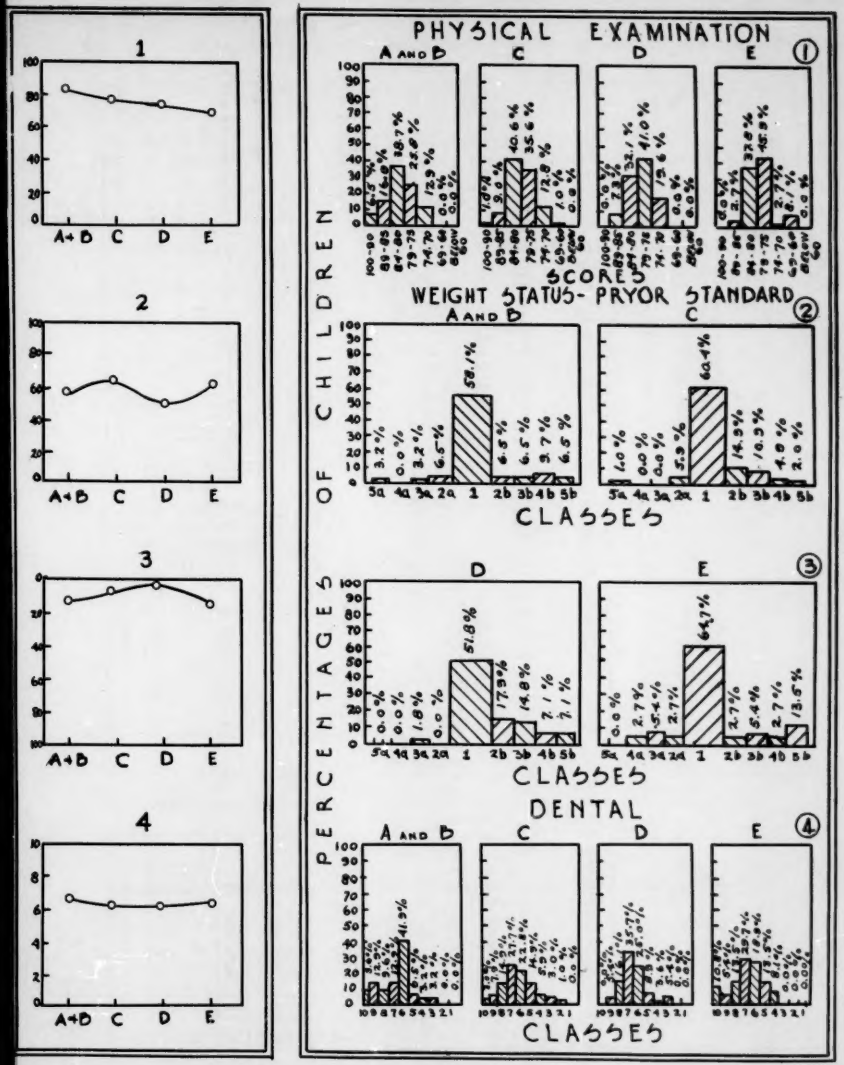
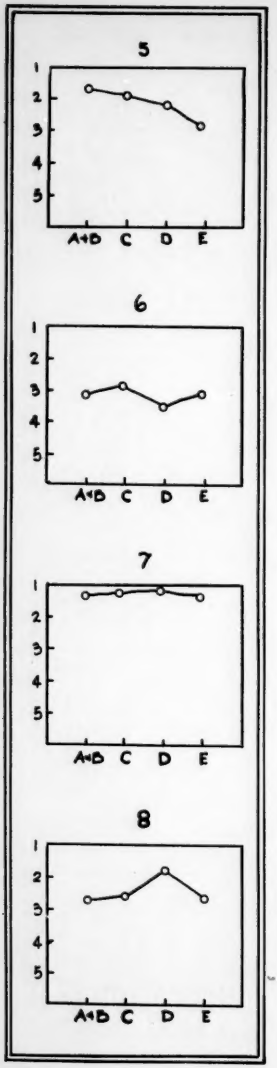



Fig. 1

For description see pages 218 and 219.



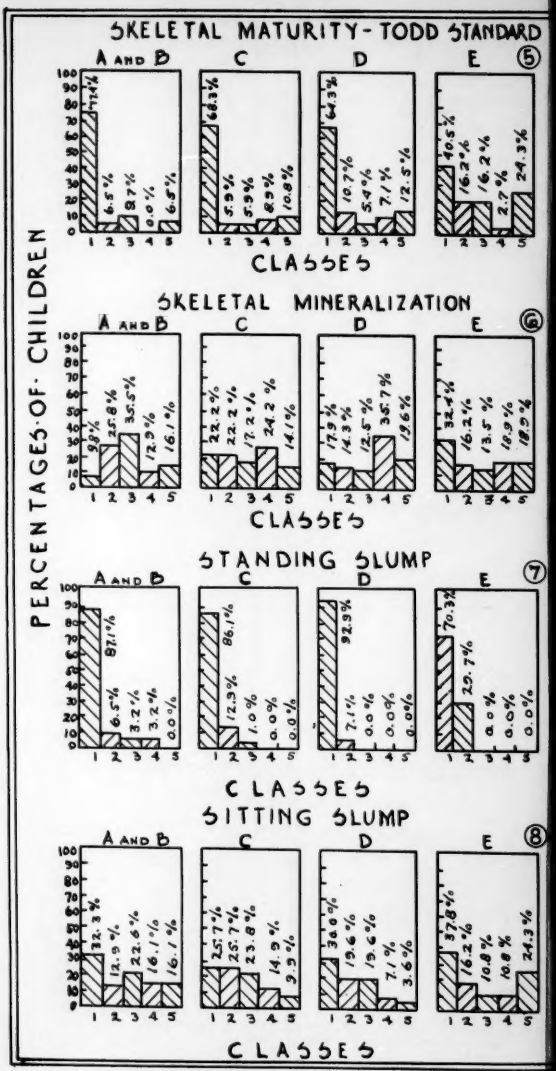




Fig. 1 (Continued)

For description see pages 218 and 219.

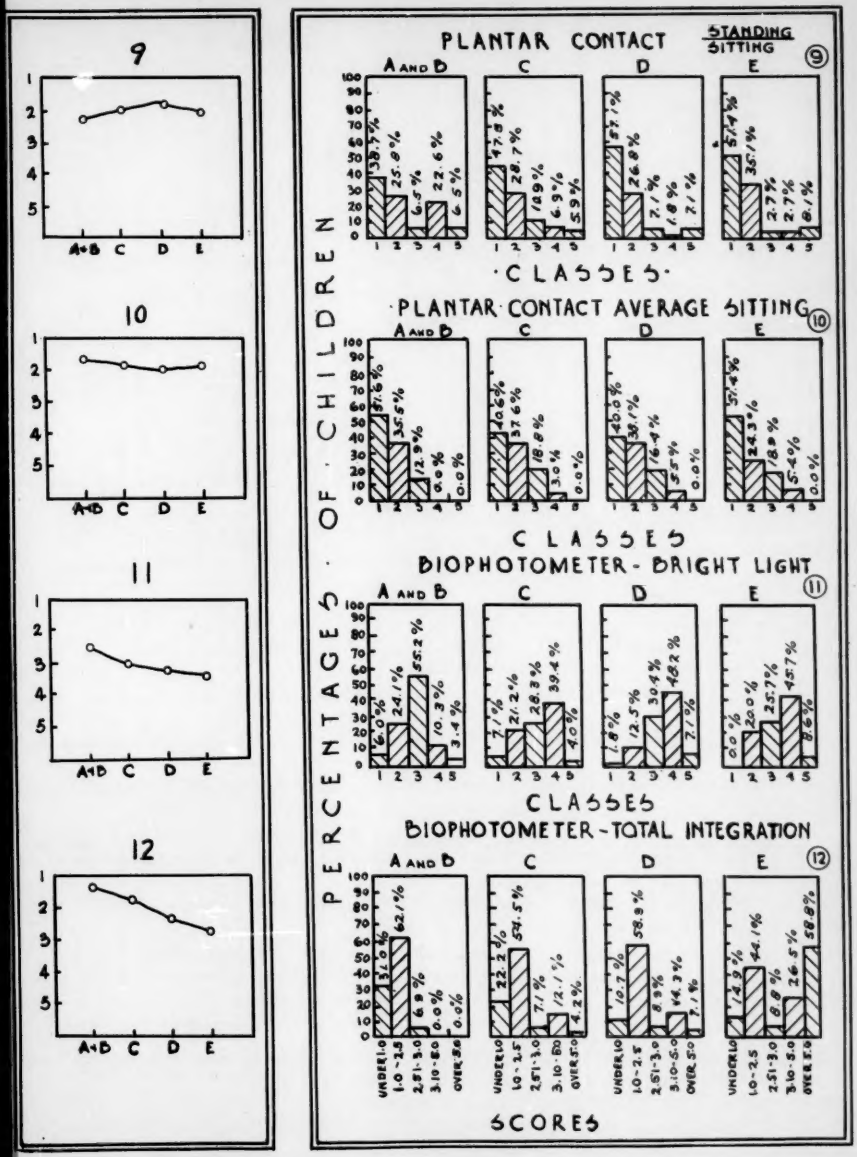



Fig. 1 (Continued)

For description see pages 218 and 219.

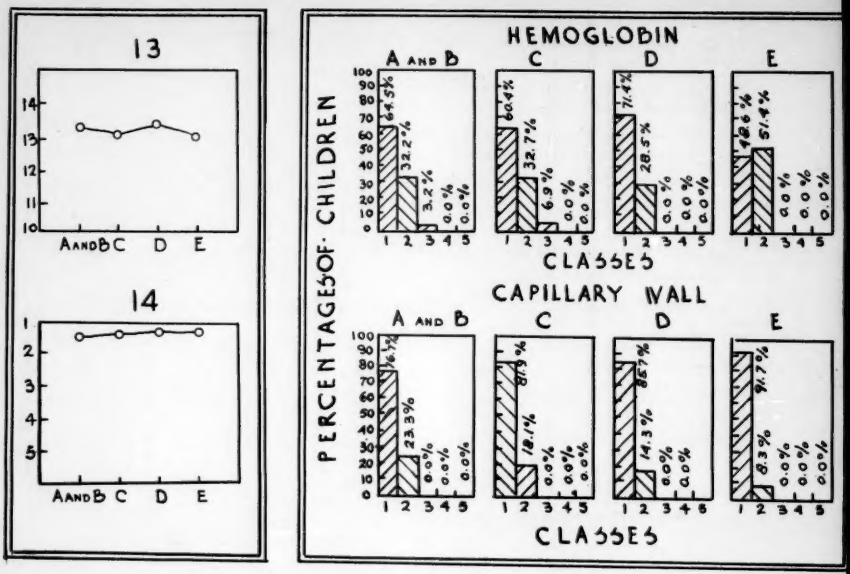



Fig. 1 (Continued)

(1) Left. Average Responses of Children of Different Income Groups to the Nutritional Rating by Physical Examination, in Terms of Scores Based on a 100-Point System.

(1) Right. Distribution of Children of Different Income Groups Among Seven Arbitrary Groupings of Physical Examination Scores.

(2) Left. Average Percentages of Children of Different Income Groups Found to be of Correct Weight ± 10 Per Cent for Their Sex, Age, Height, and Iliac Width, According to the Pryor Standards.

(3) Left. Average Percentage of Children who Were Under-Weight According to the Pryor Standards, Grouped By Income.

(2) and (3) Right. Distribution of Children of Different Income Groups Among the Various Weight Classes, with Class 1 Representing Children of Correct Weight ± 10 Per Cent, and with the (a) Groups Denoting Various Degrees of Under-Weight and the (b) of Over-Weight.

(4) Left. Average Dental Scores of Children of Different Income Groups, Based on a Rating Scheme for Dental Caries in which the Highest Score is 10.

(4) Right. Distribution of Children of Different Income Groups According to Dental Score.

(5) Left. Average Skeletal Maturity Classes of Children of Different Income Groups, with Class 1 Denoting the Highest Range of Response for This and All Tests for Which Classes are Reported.

(5) Right. Distribution of Children of Different Income Groups According to Skeletal Maturity Classes.

(6) Left. Average Skeletal Mineral Density Classes of Children of Different Income Groups.

(6) Right. Distribution of Children of Different Income Groups According to Skeletal Mineral Density Classes.

(7) Left. Average Standing Slump Classes of Children of Different Income Groups.

(7) Right. Distribution of Children of Different Income Groups According to Standing Slump Classes.

(8) Left. Average Sitting Slump Classes of Children of Different Income Groups.

(8) Right. Distribution of Children of Different Income Groups According to Sitting Slump Classes.

(9) Left. Average Plantar Contact (Ratio of Standing to Sitting) Classifications of Children of Different Income Groups.

(9) Right. Distribution of Children of Different Income Groups According to Plantar Contact (Ratio Standing to Sitting) Classes.

(10) Left. Average Plantar Contact (Percentage of Plantar Contact while Sitting) Classifications of Children of Different Income Groups.

(10) Right. Distribution of Children of Different Income Groups According to Plantar Contact (Percentage of Plantar Contact while Sitting) Classes.

(11) Left. Average Biophotometer Bright Light Classes of Children of Different Income Groups.

(11) Right. Distribution of Children of Different Income Groups According to Biophotometer Bright Light Classes.

(12) Left. Average Biophotometer Total Integration Classes of Children of Different Income Groups.

(12) Right. Distribution of Children of Different Income Groups According to Biophotometer Total Integration Classes.

(13) Left. Average Hemoglobin Values (Grams of Hemoglobin per 100 c.c. Blood) of Children of Different Income Groups.

(13) Right. Distribution of Children of Different Income Groups According to Hemoglobin Classes.

(14) Left. Average Capillary Wall Strength Classes of Children of Different Income Groups.

(14) Right. Distribution of Children of Different Income Groups According to Capillary Wall Strength Classes.

averages of the boys and of the girls were similar. Each successively lower income group averaged slightly lower than the next higher group in the physical examination scores, as is shown in Table 2, Part A, and Figure 1, Section 1. This trend is seen further in the percentage distribution of the children, grouped according to income, with respect to this test. In the figure, it may be noted that 6.5 per cent of the children in the two highest income classes, combined, were in the highest sub-division of physical rating scores, with 16.0 per cent in the second highest sub-division. In income Class C, only 1.0 per cent of the children were in the highest sub-division, with 9.0 per cent only in the second. Income Groups D and E had no children in the highest sub-division of physical rating scores, with 7.3 and 2.7 per cent, respectively, in the second highest sub-division for these two Income Groups. When two ranges of scores in the physical examination were established, one including all of 80 points and over, and the second all below this score, 61.2 per cent of the children in Income Groups A and B, combined, were in this higher range, while 50.6 per cent of Income C children, 39.4 per cent of Income D, and 40.5 per cent of Income E children were in the better classification.

Weight Status. The average percentages of children of the different income groups found to be within 10 per cent above or below the correct weight, according to the Pryor standard, shown in Table 2, Part A, and in Figure 1, Sections 2 and 3, are seen to indicate no definite trends throughout the range of income groups considered. Likewise no trend is apparent in the percentage of children who were regarded as under-weight according to the standards used, nor with respect to the distribution of

the children of the various income groups throughout the arbitrary weight classes. It has been shown by Zayaz, Mack, Sprague, and Bauman (11) that weight status was not closely related to cash income of 428 school children in an industrial community.

Dental Score. The average dental score of all of the children according to the arbitrary rating scheme for dental caries used in the study was 6.5 points; the averages of the two sexes were very similar to each other. There were no significant differences among the average dental scores of the different income groups, although the distribution graphs showing the percentage of children in the different dental score groups reveal a slight tendency for a larger percentage of children in the higher income groups to be in the highest dental rating groups. These data are presented in Table 2, Part A, and shown graphically in Figure 1, Section 4.

Skeletal Maturity. In skeletal maturity as determined by the Todd standards, all children in the study averaged Class 1.95, with the boys showing a slightly higher average than the girls, as is shown in Table 2, Part B and Figure 1, Section 5. A definite trend was apparent toward less satisfactory scores with lower income, which was consistent throughout the income range. In the graphs showing the percentage distribution of the children of different income groups in the several classes of skeletal maturity, included in Figure 1, the same tendency is seen for children of higher incomes to be in skeletal maturity classes higher than those of the lower income groups. For example, Class 1 of skeletal maturity contained 77.4 per cent of the children of Income Groups A and B, 68.3 per cent of those of Group C, 64.3 per cent of those of Group D, and 40.5 per cent of those of Group E. At the other end of the skeletal maturity scale, Class 5 contained only 6.5 per cent of the children of Income Groups A and B, combined, 10.8 per cent of those of Group C, 12.5 per cent of those of Group D, and 24.3 per cent of those of Group E.

Skeletal Mineralization. The average mineral class for all children in the study was 2.93, with the average for the boys slightly higher than that for the girls. No consistent trend could be observed for the averages of the children in the different income groups, except that the children in Income Group C were poorer than those in the higher or lower groups, as may be seen in Table 2, Part B, and in Figure 1, Section 6. The fact that the lowest income group was higher in skeletal mineralization than the next higher income groups, while being considerably lower in skeletal maturity, may be explained on the basis of the report by Zayaz, Mack, Sprague, and Bauman (11) that skeletal mineralization is in a higher class than is skeletal maturity in children of poor nutritional status, whereas the reverse is true where nutritional status is only moderately poor.

Standing and Sitting Slump. The average class rating for all children for standing and sitting slump, regardless of income level, was 1.17 and 2.49, respectively. There appears to be no definite trend in standing or sitting slump according to income class grouping, regardless of income or sex, either for averages or for percentage distribution, as may be seen in Table 2, Part B, and in Figure 1, Sections 7 and 8. This observation is in agreement with the report by Zayaz, Mack, Sprague, and Bauman (11) that no relationship was found between family income and slump ratings.

Plantar Contact. The average of all children in the study for the plantar contact standing-sitting ratio was class 1.93, with the males averaging 2.19 and females 1.71. Results of plantar contact measurements, as carried on in this laboratory, have not yet been studied sufficiently to know whether or not there is a difference between the sexes in response to this test. No definite trends are shown in the relationship between this plantar contact factor and income, as may be seen in Table 2, Part B, and in Figure 1, Sections 9 and 10. This was further borne out by the distribution of ratings on this factor within the various income groups. This is in conformity with the findings of Zayaz, Mack, Sprague, and Bauman (11).

The average class of plantar contact calculated from the average percentage of the two feet touching a level surface while the children were in a sitting position was 1.81, with the averages of the two sexes approximately equal. These plantar contact indices showed no relationship with income, in common with the plantar contact factor previously described. The percentage distribution of children of the different income groups with respect to the various classes of sitting plantar contact values again showed no relationship between income and responses to this test.

Darkness Adaptation. The average responses of the various income groups to the darkness adaptation test tended to become less satisfactory as income decreased, as shown by each of the five factors presented in Table 2, Part C. This tendency may be seen also in Figure 1, Sections 11 and 12, where the average bright light and total integration factors are graphed for the different income groups of children; the bright light factor is the value obtained in the test immediately following exposure to the bleaching light, while the total integration factor is the area under the entire biophotometer curve made according to the method described by Mack and Smith (8).

The distribution of the children in the different income groups with respect to their level of response to the biophotometer test shows the same tendency as that indicated by the averages. Whereas 30.1 per cent of the children in the two highest income groups combined were in the two highest groups of response to the bright light test, 29.3 per cent of those in the third income group, 14.3 per cent of those in the fourth, and 20.0 per cent of those in the fifth were found in these two highest groups. In the lowest two groups of response, on the other hand, only 13.7 per cent of the highest two combined income groups was found, with 43.4 per cent of those in the third income group, 55.3 per cent of those in the fourth, and 54.3 per cent of those in the fifth income groups being found in these low groups of response to the bright light photometer test.

With respect to the total integration biophotometer factor, which is a composite index of the response to the series of successive biophotometer measurements, a relationship is evident between income and darkness adaptation as shown by this test. Not only were progressively less satisfactory average total integration factors found with decreasing income, but the percentage distributions also showed the same tendency. For example, the percentages of children in the A and B income groups combined, in the C, in the D, and in the E income groups found in the two highest biophotometer total integration classes were 93.1, 76.7, 69.6,

and 59.0 per cent, respectively. In the two lowest response groups, on the other hand, the percentages were 0.0, 16.3, 21.4, and 85.3 per cent, respectively, for the same series of income groups. A similar relationship between income and response to a photometer test has been reported by Mack and Sanders (7), and by Zayaz, Mack, Sprague, and Bauman (11).

Hemoglobin. The average hemoglobin content for all of the children was 13.26 grams of hemoglobin per 100 c.c. of blood, with no significant differences between the averages of the two sexes. The average hemoglobin contents were very similar among the children of the different income groups and were all relatively high, as may be noted in Table 2, Part C, and in Figure 1, Section 13. The percentages of the children within the various income groups found in the respective levels of hemoglobin likewise showed no noteworthy trend except that, within the lowest income group, the percentage of children in the highest hemoglobin class was somewhat lower and that in the second class was somewhat higher than in the other income groups. In this lowest income group, however, there were no children in the three lowest hemoglobin classes; and the children in this as well as in all of the income groups were comparatively high in their response to this test.

Capillary Wall Strength. The average capillary wall strength of all children in the study is shown in Table 2, Part C, to be Class 1.12. The males and females were not widely different in their average response to this test, nor was any trend shown with respect to the average responses of the various income groups. Figure 1, Part 14 shows the average responses to this test of the children by income groups, as well as the distribution of the children in the different income groups with respect to this test. It is evident that all subjects in the study were in the two highest classes with respect to this test, indicating that the children of this study were not so seriously mal-nourished as were some of the subjects in other parts of the Pennsylvania mass human nutrition studies. Since this test is not specific for vitamin C, and does not indicate pre-deficiencies of this vitamin, as was believed when it first began to be used, the satisfactory response of the children in the study to this test does not necessarily indicate that they are receiving optimum quantities of vitamin C. The blood plasma ascorbic acid test of Farmer and Abt (2) as modified by McCormick (6) was not ready for general use in the Pennsylvania mass human nutrition studies until near the close of the period of record taking on the children of this study. Tests made more recently on other children in the same communities as those from which these children were taken, however, showed a wide range of blood plasma ascorbic acid values for children of high capillary wall strength.

## Family Education and Nutritional Status of the Children

The averages of response of the children to the nutrition tests, when they were grouped according to family education as rated by the arbitrary scheme used in the study, are given in Table 3, page 213. These data indicate that the responses of the children showed no consistent trends in any of the following tests: nutrition rating by physical examination, weight status, dental status, slump, plantar contact, hemoglobin, or capillary wall strength. Skeletal maturity classes as judged by the Todd standards were significantly higher in each of the two highest education

groups than in each of the three lower groups, although skeletal mineralization showed no definite tendencies. All five of the photometer factors were more satisfactory for the higher than for the lower education classes.

Since the children were chosen according to the annual cash income of the families rather than on the basis of the education of the adult family members, the distribution of subjects was more satisfactory in the former rather than in the latter socio-economic classification. Of the total 225 children chosen according to cash income, for example, 147 fell into Education Class E. This probably accounts for the fact that average responses to the nutrition tests were not so consistent among education groups as among family income groups.

### Physical Home Rating and Nutritional Status of Children

When the homes of the children were graded by a visiting registered nurse according to the scheme used in this study, none of the children was found to come from homes which would be rated in the lowest physical home class - Class E.

The average responses of the children when they were grouped according to their physical home ratings as given in Table 4, page 214, show the same general trends among the different groups as were evident among the groups classified on the basis of family income. No definite tendencies were seen in the relation of physical home group averages and weight status, dental status, slump, plantar contact, hemoglobin, or capillary wall strength. Nutrition rating by physical examination was abruptly lower for the successive groups below Physical Home Rating Class A. Average skeletal maturity classes became consistently less satisfactory with each succeeding lower physical home rating class, while skeletal mineralization class showed no definite trends. The photometer factors became less satisfactory, in general, as the physical home rating became lower, with the exception of Class D in which there were but nine cases.

## DIETARY INTAKE

The average intakes of energy, protein, calcium, phosphorus, iron, vitamins A, $B_1$, C, and riboflavin by the children grouped according to family income are found in Table 5, pages 224 and 225. The average intakes of these nutrients by the children grouped according to family education are given in Table 6, pages 226 and 227; the results, when grouped according to physical home rating are given in Table 7, pages 228 and 229. In these tables, the average intakes of the children as a whole, and of the two sexes separately are presented for breakfast, lunch, dinner, all meals, and for breakfast and dinner.

The average intakes of the various nutrients specified are shown for breakfast, for lunch, for dinner, and for all meals in Figure 2, page 230, for the children of both sexes combined, grouped separately on the basis of family income, of family education, and of physical home rating. Figure 3 gives the percentages of children grouped as to family income distributed according to their intake of the various nutrients.

TABLE 5

AVERAGE INTAKE OF DIFFERENT NUTRIENTS ACCORDING TO VARYING INCOME LEVELS*

| Income Class | Sex | Energy (Calories) | | | | | Protein (Grams) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner |
| A & B | Male | 627 | 1043 | 943 | 2613 | 1570 | 12.8 | 23.5 | 25.9 | 62.2 | 38.7 |
| | Female | 609 | 1030 | 1146 | 2785 | 1755 | 12.1 | 26.4 | 29.7 | 68.2 | 41.8 |
| | All Cases | 619 | 1037 | 1035 | 2691 | 1654 | 12.5 | 24.8 | 27.6 | 64.9 | 40.1 |
| C | Male | 505 | 769 | 875 | 2149 | 1380 | 10.2 | 21.0 | 25.1 | 56.3 | 35.3 |
| | Female | 626 | 829 | 913 | 2368 | 1539 | 11.0 | 21.4 | 23.2 | 55.6 | 34.2 |
| | All Cases | 571 | 801 | 896 | 2268 | 1467 | 10.6 | 21.2 | 24.1 | 55.9 | 34.7 |
| D | Male | 430 | 763 | 793 | 1986 | 1223 | 8.7 | 20.8 | 22.8 | 52.3 | 31.5 |
| | Female | 559 | 780 | 873 | 2212 | 1432 | 12.3 | 20.2 | 24.3 | 56.8 | 36.6 |
| | All Cases | 502 | 772 | 837 | 2111 | 1339 | 10.7 | 20.4 | 23.7 | 54.8 | 34.4 |
| E | Male | 578 | 747 | 879 | 2204 | 1457 | 10.1 | 20.1 | 24.4 | 54.6 | 34.5 |
| | Female | 467 | 704 | 772 | 1943 | 1239 | 9.4 | 17.1 | 22.2 | 48.7 | 31.6 |
| | All Cases | 509 | 721 | 812 | 2042 | 1321 | 9.6 | 18.2 | 23.0 | 50.8 | 32.6 |
| All Children | Male | 517 | 810 | 861 | 2188 | 1378 | 10.3 | 21.2 | 24.6 | 56.1 | 34.9 |
| | Female | 577 | 810 | 909 | 2296 | 1486 | 11.1 | 20.9 | 24.0 | 56.0 | 35.1 |
| | All Cases | 550 | 810 | 887 | 2247 | 1437 | 10.7 | 21.0 | 24.3 | 56.1 | 35.0 |

| Income Class | Sex | Calcium (Grams) | | | | | Phosphorus (Grams) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner |
| A & B | Male | 0.19 | 0.23 | 0.20 | 0.62 | 0.39 | 0.46 | 0.52 | 0.52 | 1.50 | 0.98 |
| | Female | 0.21 | 0.24 | 0.23 | 0.68 | 0.44 | 0.38 | 0.62 | 0.65 | 1.65 | 1.03 |
| | All Cases | 0.20 | 0.24 | 0.21 | 0.65 | 0.41 | 0.43 | 0.57 | 0.58 | 1.58 | 1.01 |
| C | Male | 0.15 | 0.18 | 0.17 | 0.50 | 0.32 | 0.28 | 0.42 | 0.51 | 1.21 | 0.79 |
| | Female | 0.14 | 0.17 | 0.17 | 0.48 | 0.31 | 0.29 | 0.47 | 0.50 | 1.26 | 0.79 |
| | All Cases | 0.15 | 0.17 | 0.17 | 0.49 | 0.32 | 0.28 | 0.45 | 0.51 | 1.24 | 0.79 |
| D | Male | 0.12 | 0.16 | 0.13 | 0.41 | 0.25 | 0.22 | 0.44 | 0.46 | 1.12 | 0.68 |
| | Female | 0.16 | 0.16 | 0.14 | 0.46 | 0.30 | 0.37 | 0.43 | 0.50 | 1.30 | 0.87 |
| | All Cases | 0.14 | 0.16 | 0.14 | 0.44 | 0.28 | 0.30 | 0.43 | 0.48 | 1.21 | 0.78 |
| E | Male | 0.12 | 0.15 | 0.14 | 0.41 | 0.26 | 0.23 | 0.39 | 0.46 | 1.08 | 0.69 |
| | Female | 0.10 | 0.12 | 0.10 | 0.32 | 0.20 | 0.22 | 0.35 | 0.36 | 0.93 | 0.58 |
| | All Cases | 0.11 | 0.13 | 0.12 | 0.36 | 0.23 | 0.22 | 0.37 | 0.40 | 0.99 | 0.62 |
| All Children | Male | 0.15 | 0.18 | 0.16 | 0.49 | 0.31 | 0.29 | 0.44 | 0.50 | 1.23 | 0.79 |
| | Female | 0.15 | 0.16 | 0.16 | 0.47 | 0.31 | 0.33 | 0.45 | 0.49 | 1.27 | 0.82 |
| | All Cases | 0.15 | 0.17 | 0.16 | 0.48 | 0.31 | 0.31 | 0.45 | 0.50 | 1.25 | 0.81 |

| Income Class | Sex | Iron (Grams) | | | | | Vitamin A (International Units) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner |
| A & B | Male | 0.0026 | 0.0050 | 0.0063 | 0.0139 | 0.0089 | 2237 | 3900 | 4124 | 10261 | 6361 |
| | Female | 0.0024 | 0.0057 | 0.0077 | 0.0158 | 0.0101 | 1217 | 3081 | 5725 | 10023 | 6942 |
| | All Cases | 0.0025 | 0.0053 | 0.0069 | 0.0147 | 0.0094 | 1776 | 3530 | 4847 | 10153 | 6623 |
| C | Male | 0.0021 | 0.0039 | 0.0064 | 0.0124 | 0.0085 | 1305 | 2235 | 3136 | 6676 | 4441 |
| | Female | 0.0021 | 0.0045 | 0.0063 | 0.0129 | 0.0084 | 1218 | 2589 | 3290 | 7097 | 4508 |
| | All Cases | 0.0021 | 0.0042 | 0.0063 | 0.0126 | 0.0084 | 1258 | 2428 | 3220 | 6906 | 4478 |
| D | Male | 0.0016 | 0.0044 | 0.0057 | 0.0117 | 0.0073 | 949 | 1967 | 2646 | 5562 | 3595 |
| | Female | 0.0024 | 0.0046 | 0.0064 | 0.0134 | 0.0088 | 1204 | 1980 | 2475 | 5659 | 3679 |
| | All Cases | 0.0020 | 0.0045 | 0.0061 | 0.0126 | 0.0081 | 1090 | 1974 | 2551 | 5615 | 3641 |
| E | Male | 0.0018 | 0.0039 | 0.0055 | 0.0112 | 0.0073 | 1154 | 2088 | 2769 | 6011 | 3923 |
| | Female | 0.0015 | 0.0043 | 0.0049 | 0.0107 | 0.0064 | 1136 | 2108 | 1958 | 5202 | 3094 |
| | All Cases | 0.0017 | 0.0041 | 0.0051 | 0.0109 | 0.0068 | 1143 | 2101 | 2265 | 5509 | 3408 |
| All Children | Male | 0.0021 | 0.0042 | 0.0061 | 0.0124 | 0.0082 | 1392 | 2374 | 3081 | 6847 | 4473 |
| | Female | 0.0021 | 0.0046 | 0.0062 | 0.0129 | 0.0083 | 1199 | 2397 | 3117 | 6713 | 4316 |
| | All Cases | 0.0021 | 0.0044 | 0.0062 | 0.0127 | 0.0083 | 1286 | 2387 | 3100 | 6773 | 4387 |

*The intake values of the various nutrient factors have been calculated to a unit person basis

TABLE 5 (Continued)

| Income Class | Sex | Vitamin $B_1$ (International Units) | | | | | Vitamin C (Milligrams) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner |
| A & B | Male | 94.2 | 161.2 | 190.3 | 445.7 | 284.5 | 42.2 | 37.9 | 50.8 | 130.9 | 93.0 |
| | Female | 103.5 | 228.2 | 243.7 | 575.4 | 347.2 | 55.1 | 39.2 | 63.2 | 157.5 | 118.3 |
| | All Cases | 98.4 | 191.5 | 214.4 | 504.3 | 312.8 | 48.0 | 38.5 | 56.4 | 142.9 | 104.4 |
| C | Male | 78.7 | 150.9 | 205.7 | 435.3 | 284.4 | 23.3 | 29.8 | 48.3 | 101.4 | 71.6 |
| | Female | 88.5 | 161.3 | 191.0 | 440.8 | 279.5 | 23.9 | 33.0 | 50.2 | 107.1 | 74.1 |
| | All Cases | 84.0 | 156.5 | 197.7 | 438.2 | 281.7 | 23.6 | 31.5 | 49.3 | 104.4 | 72.9 |
| D | Male | 53.1 | 156.5 | 200.2 | 409.8 | 253.3 | 23.3 | 26.1 | 41.3 | 90.7 | 64.6 |
| | Female | 102.7 | 142.2 | 249.0 | 493.9 | 351.7 | 16.9 | 28.3 | 54.2 | 99.4 | 71.1 |
| | All Cases | 80.5 | 148.6 | 227.2 | 456.3 | 307.7 | 19.7 | 27.3 | 48.4 | 95.4 | 68.1 |
| E | Male | 61.4 | 124.6 | 156.1 | 342.1 | 217.5 | 10.2 | 31.8 | 38.8 | 80.8 | 49.0 |
| | Female | 53.3 | 130.3 | 183.4 | 367.0 | 236.7 | 7.0 | 38.9 | 48.4 | 94.3 | 55.4 |
| | All Cases | 56.4 | 128.1 | 173.1 | 357.6 | 229.5 | 8.2 | 36.2 | 44.8 | 89.2 | 53.0 |
| All Children | Male | 72.6 | 150.3 | 194.3 | 417.2 | 266.9 | 24.6 | 30.5 | 43.8 | 98.9 | 68.4 |
| | Female | 87.2 | 158.3 | 210.2 | 455.7 | 297.4 | 22.5 | 33.6 | 52.3 | 108.4 | 74.8 |
| | All Cases | 80.6 | 154.7 | 203.0 | 438.3 | 283.6 | 23.5 | 32.2 | 48.5 | 104.2 | 72.0 |

| Income Class | Sex | Riboflavin (Milligrams) | | | | |
|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner |
| A & B | Male | 0.45 | 0.33 | 0.39 | 1.17 | 0.84 |
| | Female | 0.46 | 0.49 | 0.50 | 1.45 | 0.96 |
| | All Cases | 0.46 | 0.40 | 0.44 | 1.30 | 0.90 |
| C | Male | 0.33 | 0.32 | 0.36 | 1.01 | 0.69 |
| | Female | 0.31 | 0.30 | 0.30 | 0.91 | 0.61 |
| | All Cases | 0.32 | 0.31 | 0.33 | 0.96 | 0.65 |
| D | Male | 0.28 | 0.36 | 0.21 | 0.85 | 0.49 |
| | Female | 0.31 | 0.28 | 0.21 | 0.80 | 0.52 |
| | All Cases | 0.30 | 0.31 | 0.21 | 0.82 | 0.51 |
| E | Male | 0.20 | 0.22 | 0.33 | 0.75 | 0.53 |
| | Female | 0.22 | 0.20 | 0.13 | 0.55 | 0.35 |
| | All Cases | 0.21 | 0.21 | 0.20 | 0.62 | 0.41 |
| All Children | Male | 0.32 | 0.32 | 0.33 | 0.97 | 0.65 |
| | Female | 0.31 | 0.30 | 0.27 | 0.88 | 0.58 |
| | All Cases | 0.32 | 0.31 | 0.29 | 0.92 | 0.61 |

In arriving at the averages used in the tables and figure under consideration, food eaten between meals in the morning was added to the breakfast intake; that consumed during the afternoon and evening was added to the dinner intake.

An interesting point to consider in examining Figure 3 is the relative average amounts of the various nutrients consumed at the three meals of the day. No notable difference in the consumption at the three meals, for the entire series of groups of children divided according to each of the three socio-economic factors, was seen for the following nutrients: calcium and riboflavin. Breakfast was lower than the other two meals, which were practically the same, in consumption of the following: energy, and phosphorus. Breakfast, lunch, and dinner became progressively greater in average intake, in the main, for the following: protein, iron, vitamin A, vitamin $B_1$, and vitamin C.

## Socio-Economic Status and Dietary Intake of Children

The three socio-economic factors of family cash income, family education, and physical home rating have been found by Sanders (9) in a study

TABLE 6

AVERAGE INTAKE OF DIFFERENT NUTRIENTS ACCORDING TO VARYING EDUCATION LEVELS*

| Education Class | Sex | Energy (Calories) | | | | | Protein (Grams) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner |
| A | Male | 713 | 1141 | 1010 | 2864 | 1723 | 14.1 | 23.8 | 27.6 | 65.5 | 41.7 |
| | Female | 727 | 1105 | 1231 | 3063 | 1958 | 14.7 | 27.6 | 30.7 | 73.0 | 45.4 |
| | All Cases | 718 | 1127 | 1096 | 2941 | 1814 | 14.3 | 25.3 | 28.8 | 68.4 | 43.1 |
| B | Male | 604 | 960 | 964 | 2528 | 1568 | 12.5 | 23.7 | 25.8 | 62.0 | 38.3 |
| | Female | 489 | 879 | 1008 | 2376 | 1497 | 11.2 | 21.6 | 27.3 | 60.1 | 38.5 |
| | All Cases | 556 | 926 | 982 | 2464 | 1538 | 12.0 | 22.8 | 26.4 | 61.2 | 38.4 |
| C | Male | 379 | 802 | 915 | 2096 | 1294 | 8.9 | 21.8 | 26.2 | 56.9 | 35.1 |
| | Female | 740 | 1222 | 1155 | 3117 | 1895 | 14.2 | 23.9 | 27.6 | 65.7 | 41.8 |
| | All Cases | 499 | 942 | 995 | 2436 | 1494 | 10.7 | 22.5 | 26.7 | 59.9 | 37.4 |
| D | Male | 501 | 778 | 868 | 2147 | 1369 | 10.3 | 18.0 | 25.2 | 53.5 | 35.5 |
| | Female | 870 | 779 | 912 | 2561 | 1782 | 11.3 | 20.4 | 24.4 | 56.1 | 35.7 |
| | All Cases | 738 | 779 | 897 | 2414 | 1635 | 10.9 | 19.5 | 24.7 | 55.1 | 35.6 |
| E | Male | 478 | 722 | 804 | 2004 | 1282 | 9.2 | 20.7 | 23.5 | 53.4 | 32.7 |
| | Female | 508 | 769 | 861 | 2138 | 1369 | 10.7 | 20.2 | 22.9 | 53.8 | 33.6 |
| | All Cases | 495 | 750 | 837 | 2082 | 1332 | 10.1 | 20.4 | 23.2 | 53.7 | 33.3 |
| All Children | Male | 517 | 810 | 861 | 2188 | 1378 | 10.3 | 21.2 | 24.6 | 56.1 | 34.9 |
| | Female | 577 | 810 | 909 | 2296 | 1486 | 11.1 | 20.9 | 24.0 | 56.0 | 35.1 |
| | All Cases | 550 | 810 | 887 | 2247 | 1437 | 10.7 | 21.0 | 24.3 | 56.1 | 35.0 |

| Education Class | Sex | Calcium (Grams) | | | | | Phosphorus (Grams) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner |
| A | Male | 0.21 | 0.25 | 0.20 | 0.66 | 0.41 | 0.46 | 0.51 | 0.53 | 1.50 | 0.99 |
| | Female | 0.26 | 0.26 | 0.27 | 0.79 | 0.53 | 0.45 | 0.70 | 0.71 | 1.86 | 1.16 |
| | All Cases | 0.23 | 0.25 | 0.23 | 0.71 | 0.46 | 0.46 | 0.58 | 0.60 | 1.64 | 1.06 |
| B | Male | 0.20 | 0.22 | 0.18 | 0.60 | 0.38 | 0.37 | 0.55 | 0.57 | 1.49 | 0.94 |
| | Female | 0.17 | 0.20 | 0.19 | 0.56 | 0.36 | 0.32 | 0.48 | 0.58 | 1.38 | 0.90 |
| | All Cases | 0.19 | 0.21 | 0.18 | 0.58 | 0.37 | 0.35 | 0.52 | 0.57 | 1.44 | 0.92 |
| C | Male | 0.16 | 0.17 | 0.18 | 0.51 | 0.34 | 0.25 | 0.45 | 0.52 | 1.23 | 0.77 |
| | Female | 0.16 | 0.20 | 0.16 | 0.52 | 0.32 | 0.33 | 0.52 | 0.56 | 1.41 | 0.89 |
| | All Cases | 0.16 | 0.18 | 0.17 | 0.51 | 0.33 | 0.28 | 0.48 | 0.53 | 1.29 | 0.81 |
| D | Male | 0.16 | 0.15 | 0.19 | 0.50 | 0.35 | 0.25 | 0.37 | 0.52 | 1.14 | 0.77 |
| | Female | 0.16 | 0.16 | 0.15 | 0.47 | 0.31 | 0.31 | 0.43 | 0.50 | 1.24 | 0.81 |
| | All Cases | 0.16 | 0.16 | 0.16 | 0.48 | 0.32 | 0.29 | 0.41 | 0.51 | 1.21 | 0.80 |
| E | Male | 0.12 | 0.16 | 0.15 | 0.43 | 0.27 | 0.25 | 0.41 | 0.47 | 1.13 | 0.72 |
| | Female | 0.13 | 0.15 | 0.15 | 0.43 | 0.28 | 0.32 | 0.43 | 0.46 | 1.21 | 0.78 |
| | All Cases | 0.13 | 0.16 | 0.15 | 0.44 | 0.28 | 0.29 | 0.42 | 0.46 | 1.18 | 0.39 |
| All Children | Male | 0.15 | 0.18 | 0.16 | 0.49 | 0.31 | 0.29 | 0.44 | 0.50 | 1.23 | 0.79 |
| | Female | 0.15 | 0.16 | 0.18 | 0.47 | 0.31 | 0.33 | 0.45 | 0.49 | 1.27 | 0.82 |
| | All Cases | 0.15 | 0.17 | 0.16 | 0.48 | 0.31 | 0.31 | 0.45 | 0.50 | 1.25 | 0.81 |

| Education Class | Sex | Iron (Grams) | | | | | Vitamin A (International Units) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner |
| A | Male | 0.0031 | 0.0051 | 0.0074 | 0.0156 | 0.0105 | 1876 | 3852 | 3971 | 9699 | 5847 |
| | Female | 0.0030 | 0.0058 | 0.0076 | 0.0164 | 0.0106 | 1508 | 3260 | 4609 | 9377 | 6117 |
| | All Cases | 0.0031 | 0.0054 | 0.0075 | 0.0160 | 0.0106 | 1733 | 3622 | 4219 | 9574 | 5952 |
| B | Male | 0.0025 | 0.0048 | 0.0066 | 0.0139 | 0.0091 | 2361 | 3733 | 4250 | 10344 | 6611 |
| | Female | 0.0022 | 0.0043 | 0.0080 | 0.0145 | 0.0102 | 1047 | 2329 | 5185 | 8561 | 6232 |
| | All Cases | 0.0023 | 0.0046 | 0.0072 | 0.0141 | 0.0095 | 1814 | 3148 | 4639 | 9601 | 6453 |
| C | Male | 0.0015 | 0.0052 | 0.0068 | 0.0135 | 0.0083 | 971 | 1946 | 3247 | 6164 | 4218 |
| | Female | 0.0026 | 0.0045 | 0.0070 | 0.0141 | 0.0096 | 1731 | 2385 | 3510 | 6626 | 4241 |
| | All Cases | 0.0019 | 0.0050 | 0.0069 | 0.0138 | 0.0088 | 1294 | 2092 | 3002 | 6318 | 4226 |
| D | Male | 0.0016 | 0.0042 | 0.0061 | 0.0119 | 0.0077 | 1327 | 2228 | 3528 | 7083 | 4855 |
| | Female | 0.0023 | 0.0045 | 0.0058 | 0.0126 | 0.0081 | 1416 | 2602 | 3462 | 7480 | 4878 |
| | All Cases | 0.0020 | 0.0044 | 0.0059 | 0.0123 | 0.0079 | 1384 | 2469 | 3485 | 7338 | 4869 |
| E | Male | 0.0020 | 0.0038 | 0.0056 | 0.0114 | 0.0076 | 1134 | 1861 | 2562 | 5557 | 3696 |
| | Female | 0.0020 | 0.0046 | 0.0059 | 0.0125 | 0.0079 | 1127 | 2291 | 2699 | 6117 | 3826 |
| | All Cases | 0.0020 | 0.0043 | 0.0058 | 0.0121 | 0.0078 | 1130 | 2111 | 2642 | 5883 | 3772 |
| All Children | Male | 0.0021 | 0.0042 | 0.0061 | 0.0124 | 0.0082 | 1392 | 2374 | 3081 | 6847 | 4473 |
| | Female | 0.0021 | 0.0046 | 0.0062 | 0.0129 | 0.0083 | 1199 | 2397 | 3117 | 6713 | 4316 |
| | All Cases | 0.0021 | 0.0044 | 0.0062 | 0.0127 | 0.0083 | 1286 | 2387 | 3100 | 6773 | 4387 |

*The intake values of the various nutrient factors have been calculated to a unit person basis.

TABLE 6 (Continued)

| Education Class | Sex | Vitamin $B_1$ (Instructional Units) | | | | | Vitamin C (Milligrams) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner |
| A | Male | 158.3 | 150.9 | 234.8 | 544.0 | 393.1 | 49.2 | 41.4 | 57.7 | 148.3 | 106.9 |
| | Female | 117.1 | 263.6 | 245.2 | 625.9 | 362.3 | 57.0 | 41.1 | 67.8 | 165.9 | 124.8 |
| | All Cases | 142.3 | 194.7 | 238.8 | 575.8 | 381.1 | 52.2 | 41.3 | 61.6 | 155.1 | 113.8 |
| B | Male | 95.7 | 203.2 | 203.6 | 502.5 | 299.3 | 39.8 | 31.3 | 47.3 | 118.4 | 87.1 |
| | Female | 85.4 | 174.8 | 236.9 | 497.1 | 322.3 | 41.6 | 25.8 | 59.7 | 127.1 | 101.3 |
| | All Cases | 91.4 | 191.3 | 217.6 | 500.2 | 308.9 | 40.5 | 29.0 | 52.5 | 122.0 | 93.0 |
| C | Male | 61.1 | 131.2 | 194.2 | 386.5 | 255.3 | 19.5 | 40.1 | 47.8 | 107.4 | 67.3 |
| | Female | 80.0 | 151.3 | 189.2 | 330.5 | 269.2 | 20.8 | 15.7 | 27.8 | 64.3 | 48.6 |
| | All Cases | 67.4 | 127.9 | 172.5 | 367.8 | 239.9 | 19.9 | 32.0 | 41.1 | 93.0 | 61.0 |
| D | Male | 54.5 | 126.8 | 246.8 | 428.1 | 301.3 | 18.8 | 34.4 | 54.4 | 97.6 | 73.2 |
| | Female | 101.4 | 158.9 | 253.8 | 514.1 | 355.2 | 21.6 | 40.4 | 52.9 | 114.9 | 74.5 |
| | All Cases | 84.6 | 147.4 | 251.3 | 483.3 | 335.9 | 20.6 | 34.7 | 53.4 | 108.7 | 74.0 |
| E | Male | 56.0 | 143.8 | 176.3 | 376.1 | 232.3 | 18.2 | 28.4 | 38.4 | 85.0 | 56.6 |
| | Female | 82.2 | 148.9 | 197.8 | 428.9 | 280.0 | 17.7 | 33.1 | 50.9 | 101.7 | 68.6 |
| | All Cases | 71.2 | 146.8 | 188.8 | 406.8 | 260.0 | 17.9 | 31.1 | 45.7 | 94.7 | 63.6 |
| All Children | Male | 72.6 | 150.3 | 194.3 | 417.2 | 266.9 | 24.6 | 30.5 | 43.8 | 98.9 | 68.4 |
| | Female | 87.2 | 158.3 | 210.2 | 456.7 | 297.4 | 22.5 | 33.6 | 52.3 | 108.4 | 74.8 |
| | All Cases | 80.6 | 154.7 | 203.0 | 438.3 | 283.6 | 23.6 | 32.2 | 48.5 | 104.2 | 72.0 |

| Education Class | Sex | Riboflavin (Milligrams) | | | | |
|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner |
| A | Male | 0.50 | 0.35 | 0.33 | 1.18 | 0.83 |
| | Female | 0.56 | 0.49 | 0.57 | 1.62 | 1.13 |
| | All Cases | 0.52 | 0.40 | 0.42 | 1.34 | 0.94 |
| B | Male | 0.46 | 0.39 | 0.43 | 1.28 | 0.89 |
| | Female | 0.41 | 0.38 | 0.36 | 1.16 | 0.77 |
| | All Cases | 0.44 | 0.39 | 0.40 | 1.23 | 0.84 |
| C | Male | 0.38 | 0.35 | 0.32 | 1.05 | 0.70 |
| | Female | 0.38 | 0.39 | 0.38 | 1.15 | 0.76 |
| | All Cases | 0.38 | 0.36 | 0.34 | 1.08 | 0.72 |
| D | Male | 0.33 | 0.28 | 0.41 | 1.02 | 0.74 |
| | Female | 0.35 | 0.31 | 0.27 | 0.93 | 0.62 |
| | All Cases | 0.34 | 0.30 | 0.32 | 0.96 | 0.66 |
| E | Male | 0.25 | 0.30 | 0.29 | 0.84 | 0.54 |
| | Female | 0.27 | 0.27 | 0.22 | 0.76 | 0.49 |
| | All Cases | 0.26 | 0.28 | 0.25 | 0.79 | 0.51 |
| All Children | Male | 0.32 | 0.32 | 0.33 | 0.97 | 0.65 |
| | Female | 0.31 | 0.30 | 0.27 | 0.88 | 0.58 |
| | All Cases | 0.32 | 0.31 | 0.29 | 0.92 | 0.61 |

of dietary habits and nutritional status of family members to be closely related to each other, and to intake of various nutrients by members of a family. Sanders found that family income and education were more closely correlated with each other than with physical home rating, and that each of these was more closely related to dietary intake than was physical home rating. In this study, all three factors were considered in order to find which ones might be useful in determining which children in a school system might require foods in addition to the diets received at home, in order to attain satisfactory nutritional status. Whereas dietary intake of the various nutrients under consideration showed the same general trends for all three nutritional factors, physical home rating appeared in this study, as in Sanders, to give the least consistent results. Where no other means of arriving at the family income or education were available, however, the latter factor could be used as a means of obtaining an estimate of the probable dietary needs of a child. It would seem that the first two factors, particularly the former, however, could be ascertained more readily than the last.

TABLE 7

AVERAGE INTAKE OF DIFFERENT NUTRIENTS ACCORDING TO VARIOUS PHYSICAL HOME LEVELS*

| Physical Home Class | Sex | Energy (Calories) | | | | | Protein (Grams) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner |
| A | Male | 557 | 852 | 923 | 2332 | 1480 | 10.9 | 21.1 | 26.1 | 58.1 | 37.0 |
| | Female | 716 | 885 | 1044 | 2645 | 1760 | 12.5 | 22.1 | 25.5 | 60.1 | 38.0 |
| | All Cases | 634 | 868 | 982 | 2484 | 1616 | 11.7 | 21.6 | 25.8 | 59.1 | 37.5 |
| B | Male | 435 | 750 | 811 | 1996 | 1246 | 9.2 | 22.6 | 24.1 | 55.9 | 33.3 |
| | Female | 487 | 810 | 875 | 2172 | 1362 | 10.7 | 20.7 | 22.8 | 54.2 | 33.5 |
| | All Cases | 463 | 783 | 845 | 2091 | 1308 | 10.0 | 21.6 | 23.4 | 55.0 | 33.4 |
| C | Male | 433 | 794 | 714 | 1942 | 1148 | 9.6 | 18.9 | 19.2 | 47.7 | 28.8 |
| | Female | 470 | 701 | 768 | 1939 | 1238 | 9.4 | 19.9 | 24.9 | 54.2 | 34.3 |
| | All Cases | 460 | 728 | 753 | 1941 | 1213 | 9.5 | 19.6 | 23.2 | 52.3 | 32.7 |
| D | Male | 888 | 867 | 1067 | 2822 | 1955 | 12.1 | 18.5 | 25.2 | 55.8 | 37.3 |
| | Female | 520 | 679 | 638 | 1837 | 1158 | 10.5 | 14.8 | 14.9 | 40.2 | 25.4 |
| | All Cases | 683 | 762 | 829 | 2274 | 1512 | 11.2 | 16.5 | 19.5 | 47.2 | 30.7 |
| All Children | Male | 517 | 810 | 861 | 2188 | 1378 | 10.3 | 21.2 | 24.6 | 56.1 | 34.9 |
| | Female | 577 | 810 | 909 | 2296 | 1486 | 11.1 | 20.9 | 24.0 | 56.0 | 35.1 |
| | All Cases | 550 | 810 | 887 | 2247 | 1437 | 10.7 | 21.0 | 24.3 | 56.1 | 35.0 |

| Physical Home Class | Sex | Calcium (Grams) | | | | | Phosphorus (Grams) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner |
| A | Male | 0.17 | 0.20 | 0.17 | 0.54 | 0.34 | 0.32 | 0.44 | 0.49 | 1.25 | 0.81 |
| | Female | 0.18 | 0.19 | 0.18 | 0.55 | 0.36 | 0.34 | 0.49 | 0.56 | 1.39 | 0.90 |
| | All Cases | 0.17 | 0.20 | 0.18 | 0.55 | 0.35 | 0.33 | 0.47 | 0.52 | 1.32 | 0.85 |
| B | Male | 0.13 | 0.17 | 0.16 | 0.46 | 0.29 | 0.26 | 0.44 | 0.46 | 1.16 | 0.72 |
| | Female | 0.13 | 0.16 | 0.16 | 0.45 | 0.29 | 0.31 | 0.46 | 0.48 | 1.25 | 0.79 |
| | All Cases | 0.13 | 0.16 | 0.16 | 0.45 | 0.29 | 0.29 | 0.45 | 0.47 | 1.21 | 0.76 |
| C | Male | 0.14 | 0.14 | 0.15 | 0.43 | 0.29 | 0.24 | 0.38 | 0.43 | 1.05 | 0.67 |
| | Female | 0.11 | 0.13 | 0.12 | 0.36 | 0.23 | 0.25 | 0.40 | 0.43 | 1.08 | 0.68 |
| | All Cases | 0.12 | 0.13 | 0.13 | 0.38 | 0.25 | 0.25 | 0.40 | 0.43 | 1.08 | 0.68 |
| D | Male | 0.13 | 0.11 | 0.13 | 0.37 | 0.26 | 0.25 | 0.31 | 0.45 | 1.01 | 0.70 |
| | Female | 0.13 | 0.11 | 0.07 | 0.31 | 0.20 | 0.22 | 0.31 | 0.28 | 0.81 | 0.50 |
| | All Cases | 0.13 | 0.11 | 0.10 | 0.34 | 0.23 | 0.23 | 0.31 | 0.35 | 0.91 | 0.60 |
| All Children | Male | 0.15 | 0.18 | 0.16 | 0.49 | 0.31 | 0.29 | 0.44 | 0.50 | 1.23 | 0.79 |
| | Female | 0.15 | 0.16 | 0.16 | 0.47 | 0.31 | 0.33 | 0.45 | 0.49 | 1.27 | 0.82 |
| | All Cases | 0.15 | 0.17 | 0.16 | 0.48 | 0.31 | 0.31 | 0.45 | 0.50 | 1.25 | 0.81 |

| Physical Home Class | Sex | Iron (Grams) | | | | | Vitamin A (International Units) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner |
| A | Male | 0.0022 | 0.0043 | 0.0066 | 0.0131 | 0.0088 | 1676 | 2915 | 3795 | 8386 | 5471 |
| | Female | 0.0024 | 0.0046 | 0.0068 | 0.0138 | 0.0092 | 1343 | 2646 | 4186 | 8175 | 5529 |
| | All Cases | 0.0023 | 0.0044 | 0.0067 | 0.0134 | 0.0090 | 1515 | 2784 | 3985 | 8284 | 5500 |
| B | Male | 0.0020 | 0.0044 | 0.0059 | 0.0123 | 0.0079 | 1128 | 2094 | 2306 | 5528 | 3434 |
| | Female | 0.0019 | 0.0050 | 0.0063 | 0.0132 | 0.0082 | 1114 | 2597 | 2857 | 6568 | 3971 |
| | All Cases | 0.0019 | 0.0047 | 0.0062 | 0.0128 | 0.0081 | 1120 | 2366 | 2605 | 6091 | 3725 |
| C | Male | 0.0014 | 0.0037 | 0.0044 | 0.0095 | 0.0058 | 857 | 1705 | 1696 | 4258 | 2553 |
| | Female | 0.0020 | 0.0044 | 0.0054 | 0.0118 | 0.0074 | 1059 | 1852 | 1904 | 4815 | 2963 |
| | All Cases | 0.0018 | 0.0042 | 0.0051 | 0.0111 | 0.0069 | 1000 | 1809 | 1843 | 4652 | 2843 |
| D | Male | 0.0024 | 0.0038 | 0.0063 | 0.0125 | 0.0087 | 1402 | 2130 | 4156 | 7688 | 5558 |
| | Female | 0.0017 | 0.0038 | 0.0040 | 0.0095 | 0.0057 | 1238 | 1616 | 1479 | 4333 | 2717 |
| | All Cases | 0.0020 | 0.0038 | 0.0050 | 0.0108 | 0.0070 | 1311 | 1789 | 2669 | 5769 | 3980 |
| All Children | Male | 0.0021 | 0.0042 | 0.0061 | 0.0124 | 0.0082 | 1392 | 2374 | 3081 | 6847 | 4473 |
| | Female | 0.0021 | 0.0046 | 0.0062 | 0.0129 | 0.0083 | 1199 | 2397 | 3117 | 6713 | 4316 |
| | All Cases | 0.0021 | 0.0044 | 0.0062 | 0.0127 | 0.0083 | 1286 | 2387 | 3100 | 6773 | 4387 |

*The intake values of the various nutrient factors have been calculated to a unit person basis.

TABLE 7 (Continued)

| Physical Home Class | Sex | Vitamin $B_1$ (International Units) | | | | | Vitamin C (Milligrams) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner |
| A | Male | 74.8 | 155.3 | 214.9 | 445.0 | 289.7 | 28.7 | 34.0 | 55.2 | 117.9 | 83.9 |
| | Female | 89.0 | 180.0 | 224.2 | 493.2 | 313.2 | 36.0 | 34.4 | 58.2 | 128.6 | 94.2 |
| | All Cases | 81.7 | 167.2 | 219.4 | 468.3 | 301.1 | 32.3 | 34.2 | 56.7 | 123.2 | 89.0 |
| B | Male | 73.9 | 153.1 | 183.4 | 410.4 | 257.3 | 24.8 | 26.5 | 32.8 | 84.1 | 57.6 |
| | Female | 76.5 | 149.9 | 221.5 | 447.9 | 298.0 | 16.0 | 37.9 | 55.2 | 109.1 | 71.2 |
| | All Cases | 75.3 | 151.4 | 204.1 | 430.8 | 279.4 | 20.0 | 32.7 | 45.0 | 97.7 | 65.0 |
| C | Male | 66.1 | 138.2 | 157.7 | 361.0 | 222.8 | 11.1 | 23.8 | 39.8 | 74.7 | 50.9 |
| | Female | 106.0 | 136.4 | 168.7 | 411.1 | 274.7 | 9.3 | 26.4 | 37.9 | 73.6 | 47.2 |
| | All Cases | 94.0 | 136.9 | 165.5 | 396.4 | 259.5 | 9.8 | 25.7 | 38.4 | 73 .9 | 48.2 |
| D | Male | 55.1 | 99.1 | 137.6 | 291.8 | 192.7 | 3.8 | 34.9 | 48.5 | 87.2 | 52.3 |
| | Female | 44.2 | 147.8 | 208.4 | 400.4 | 252.6 | 14.7 | 34.0 | 54.2 | 102.9 | 68.9 |
| | All Cases | 49.0 | 126.1 | 176.9 | 352.0 | 225.9 | 9.8 | 34.4 | 51.7 | 95.9 | 61.5 |
| All Children | Male | 72.6 | 150.3 | 194.3 | 417.2 | 266.8 | 24.6 | 30.5 | 43.8 | 98.9 | 68.4 |
| | Female | 87.2 | 158.3 | 210.2 | 455.7 | 297.4 | 22.5 | 33.6 | 52.3 | 108.4 | 74.8 |
| | All Cases | 80.6 | 154.7 | 203.0 | 438.3 | 283.6 | 23.5 | 32.2 | 48.5 | 104.2 | 72.0 |

| Physical Home Class | Sex | Riboflavin (Milligrams) | | | | |
|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Total | Breakfast and Dinner |
| A | Male | 0.37 | 0.33 | 0.35 | 1.05 | 0.72 |
| | Female | 0.38 | 0.37 | 0.36 | 1.11 | 0.74 |
| | All Cases | 0.37 | 0.35 | 0.36 | 1.08 | 0.73 |
| B | Male | 0.28 | 0.38 | 0.29 | 0.96 | 0.57 |
| | Female | 0.28 | 0.29 | 0.26 | 0.83 | 0.54 |
| | All Cases | 0.28 | 0.33 | 0.27 | 0.88 | 0.55 |
| C | Male | 0.27 | 0.16 | 0.28 | 0.71 | 0.55 |
| | Female | 0.26 | 0.20 | 0.14 | 0.60 | 0.40 |
| | All Cases | 0.26 | 0.19 | 0.18 | 0.63 | 0.44 |
| D | Male | 0.22 | 0.20 | 0.42 | 0.84 | 0.64 |
| | Female | 0.19 | 0.20 | 0.06 | 0.45 | 0.25 |
| | All Cases | 0.20 | 0.20 | 0.22 | 0.62 | 0.42 |
| All Children | Male | 0.32 | 0.32 | 0.33 | 0.97 | 0.65 |
| | Female | 0.31 | 0.30 | 0.27 | 0.88 | 0.58 |
| | All Cases | 0.32 | 0.31 | 0.29 | 0.92 | 0.61 |

Energy. It is seen from Tables 5, 6, and 7, and from Figure 2 that the average energy intake of the children tended to fall slightly with descending classes of family income, family education, and physical home rating, with the results based on the last factor showing less consistent trends than those based on the other two, as has been mentioned. The average range of daily energy intake per unit person, with the children grouped according to family income, ranged from 2691 calories for those in the two highest income groups, to 2042 calories for those in the lowest group. The average of the highest income groups approached the 3000 unit person calorie requirement estimated by the Bureau of Home Economics as outlined by Stiebeling and Phipard (10), whereas that of the lowest income group was approximately 30 per cent below this standard.

The distribution of the children among five arbitrary groups of energy intake based on the range of intake of the children in the study, as shown in Figure 3, Sections 1, 2, 3, and 4, exhibits the same tendencies for the various income groups as was shown by the average intakes. For

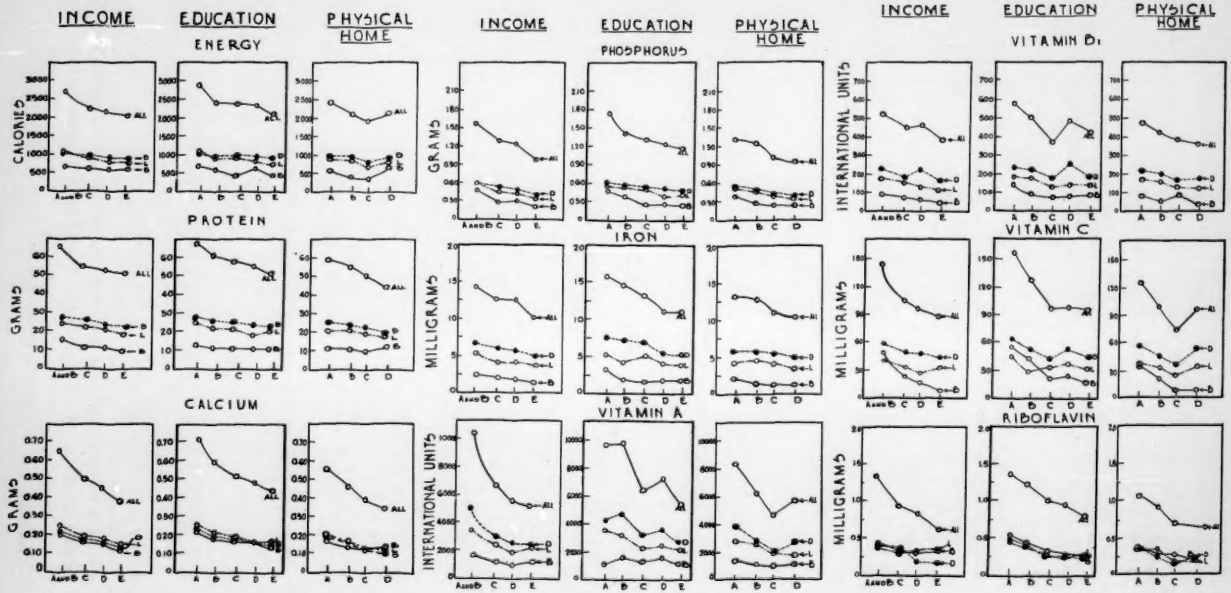



Fig. 2. Intakes of Energy, of Protein, and of Calcium by the Children Grouped as to Family Income, Family Education, and Physical Home Rating. The intakes were calculated on the Basis of Unit Person Intake for all Meals (Marked All), for Breakfast (B), for Lunch (L), and for Dinner (D).

Intakes of Phosphorus, of Iron, and of Vitamin A by the Children Grouped as to Family Income, Family Education, and Physical Home Rating. The Intakes were Calculated on the Basis of Unit Person Intake for All Meals (Marked All), for Breakfast (B), for Lunch (L), and for Dinner (D).

Intakes of Vitamin $B_1$, of Vitamin C, and of Riboflavin by the Children Grouped as to Family Income, Family Education, and Physical Home Rating. The Intakes were Calculated on the Basis of Unit Person Intake for All Meals (Marked All), for Breakfast (B), for Lunch (L), and for Dinner (D).

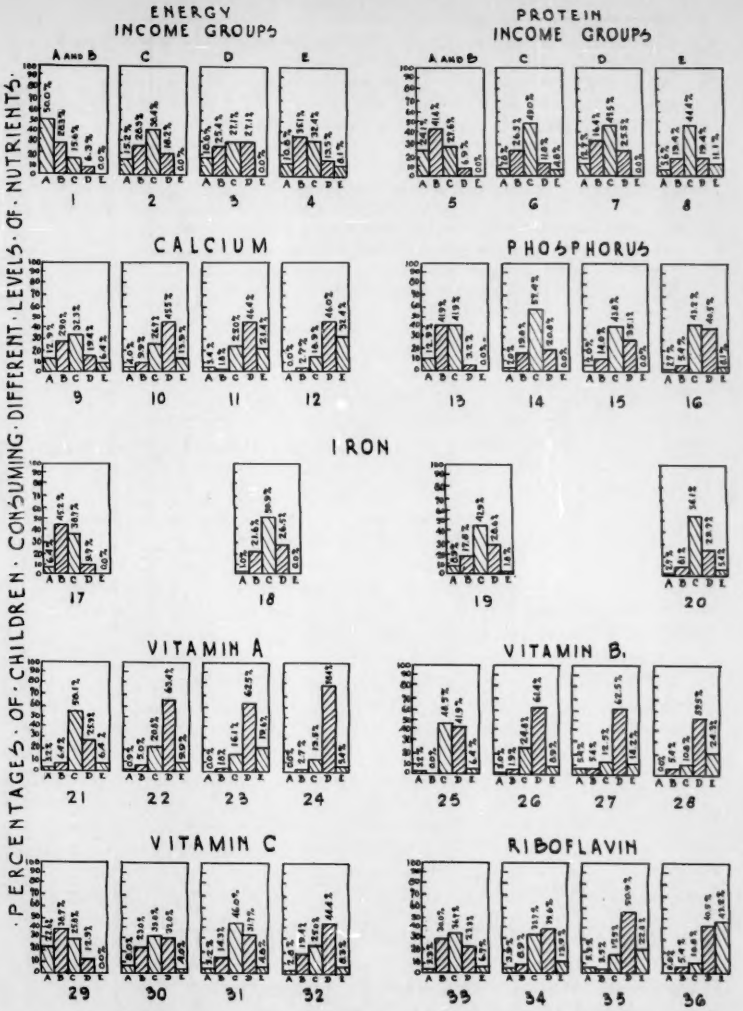



Fig. 3. Percentages of Children Grouped as to Family Income, Distributed According to Intake of Nutrients. The Intake of Energy in Calories is given in Sections 1, 2, 3, and 4; that of Protein in Grams in Sections 5, 6, 7 and 8; that of Calcium in Grams in Sections 9, 10, 11, and 12; that of Phosphorus in Grams in Sections 13, 14, 15, and 16; that of Iron in Grams in Sections 17, 18, 19, and 20; that of Vitamin A in International Units in Sections 21, 22, 23, and 24; that of Vitamin $B_1$ in International Units in Sections 25, 26, 27, and 28; that of Vitamin C in Milligrams in Sections 29, 30, 31, and 32; and that in Riboflavin in Sections 33, 34, 35, and 36.

Key to Energy Intake Groups: A = 2800 calories and above; B = 2799 - 2200; C = 2199 to 1600;

D = 1599 - 1000; and E = Below 1000 calories.

Key to Protein Intake Groups: A = 75 grams and above; B = 74 - 60; C = 59 - 45; D = 44 - 30; and E = Below 30 grams.

Key to Calcium Intake Groups: A = 0.89 grams and above; B = 0.88 - 0.69; C = 0.68 - 0.49; D = 0.48 - 0.29; and E = Below 0.29 grams.

Key to Phosphorus Intake Groups: A = 2.00 grams and above; B = 1.99 - 1.50; C = 1.49 - 1.00; D = 0.99 - 0.50; E = Below 0.50.

Key to Iron Intake Groups: A = 0.0200 grams and above; B = 0.0199 - 0.0150; C = 0.0149 to 0.0100; D = 0.0099 - 0.0050; and E = Below 0.0050 grams.

Key to Vitamin A Intake Groups: A = 24,000 International Units and above; B = 23,999 - 13,000; C = 12,999 - 8,000; D = 7,999 - 3,000; and E = Below 3,000 grams.

Key to Vitamin $B_1$ Intake Groups: A = 1,000 International Units and above; B = 999 - 750; C = 749 - 500; D = 499 - 250; and E = Below 250 International Units.

Key to Vitamin C Intake Groups: A = 120 Milligrams and above; B = 119 - 90; C = 89 - 60; D = 59 - 30; and E = Below 30 Milligrams.

Key to Riboflavin Intake Groups: A = 1.80 Milligrams and above; B = 1.79 - 1.30; C = 1.29 - 0.80; D = 0.79 - 0.30; and E = Below 0.30 Milligrams.

example, 50.0 per cent of the children of the A and B Income Groups, combined, had an energy intake of 2800 calories per unit person, daily, with 28.3 per cent of the children of these income groups consuming from 2799 to 2200 calories, 15.6 per cent from 2199 to 1600 calories, 6.3 per cent from 1599 to 1000 calories, and none falling below 1000 calories. The children in the successively lower income groups had a general tendency toward lower percentages of their numbers in the higher energy intake groups and higher percentages of their numbers in the lower energy intake groups, although only Income Group E included any children eating less than 1000 calories per unit person, daily.

Protein. The average protein intake gradually declined with lowered family income, family education, and physical home rating. The highest income group was the only one which approached the Bureau of Home Economics standard of 67 grams per unit person, daily, with the lowest income group averaging only about 75 per cent of this amount.

The distribution graphs of the children of different income groups with respect to their protein intake, as shown in Figure 3, Sections 5, 6, 7, and 8, shows a decreasing percentage of children in the higher protein intake groups and an increasing percentage in the lower groups as incomes became lower. Thus, in the highest income grouping (Incomes A and B, combined) 24.1 per cent of the children consumed 75 grams or more of protein per unit person, daily, and 41.4 per cent consumed from 74 to 60 grams, while 34.3 per cent of the children in Income Group C, 29.1 per cent of those in Income Group D, and 25.0 per cent of those in Group E were included within these two highest protein intake groups. In Income Groups A and B, combined, on the other hand, 27.6 per cent of the children were included in the third group with respect to protein intake (59 to 45 grams per unit person, daily), with 6.9 per cent consuming from 44 to 30 grams, and none receiving less than 30 grams per unit person, daily. A general tendency was shown for the percentages of the children to be greater in the three lower groups of protein intake as income was less, with 11.1 per cent of the children in Income Group E consuming less than 30 grams of protein daily.

Calcium. The intake of calcium fell off sharply with decreases in

the socio-economic ratings of the children according to each of the three arbitrary factors used. With respect to family cash income, the unit person requirement according to the Bureau of Home Economics of 0.68 grams of calcium daily was approached by the averages of the highest income group only, with sharp and consistent decreases in calcium intake for each successively lower income group. The average for the lowest income group was only about 50 per cent of the standard.

When the children were grouped as to cash income and distributed as to their level of calcium consumption, it may be seen in Figure 3, Sections 9, 10, 11, and 12, that 12.9 per cent of those in Income Groups A and B, combined, consumed 0.89 grams of calcium and above, with 29.0 per cent consuming from 0.88 to 0.69, 32.3 per cent from 0.68 to 0.49, 19.4 per cent from 0.48 to 0.29, and 6.4 per cent less than 0.29 grams per unit person, daily. The lower income groups showed a consistent tendency toward a decrease in the percentage in the groups of high calcium intake and an increase in the groups with lower intake, as income decreased.

Phosphorus. The intake of phorphorus was gradually less with lowering socio-economic status, although the decline was not so abrupt as that of calcium. The average of the highest two income groups (A and B, combined) slightly exceeded the Bureau of Home Economics unit person daily requirement of 1.32 grams of phosphorus, whereas Income Groups C and D were only slightly below this standard; Income Group E averaged but 75 per cent of the standard, approximately.

When the children were grouped as to family income and distributed as to phosphorus intake, as shown in Figure 3, Sections 13, 14, 15, and 16, it was found that 12.9 per cent of the children in Income Groups A and B, combined, were included in the highest arbitrary group of phosphorus intake (2.0 grams and above per unit person, daily), 41.9 per cent consumed from 1.99 to 1.50 grams, 41.9 per cent from 1.49 to 1.00, 3.2 per cent from 0.99 to 0.50, and 0.0 per cent below 0.50 grams of phosphorus per unit person, daily. The percentages of children in the higher phosphorus intake groups decreased gradually, but consistently, while those in the lower intake groups increased as income was less. Although no children in the first four income groups were found to consume less than 0.50 grams of phosphorus daily, 8.1 per cent of those in Income Group E received less than this amount.

Iron. The children showed gradual decreases in iron intake as family income, family education, and physical home rating decreased. In the income groups, the Bureau of Home Economics unit person requirement of 0.015 grams per day was met by the A and B combined groups, whereas the lowest income groups averaged approximately 75 per cent of the standard.

In iron intake, as seen in Figure 3, Sections 17, 18, 19, and 20, the number of children in Income Groups A and B, combined, receiving 0.020 grams of iron or above, per unit person, daily, was 6.4 per cent of the total, with 45.2 per cent consuming from 0.0199 to 0.0150 grams, 38.7 per cent from 0.0149 to 0.0100, 9.7 per cent from 0.0099 to 0.0050, and none consuming below 0.0050 grams. The other income groups displayed the same tendency as was indicated by the averages for iron, namely - a gradual decrease in the percentages of those in high iron intake groups, with an increase in those in the lower groups as incomes decreased.

Vitamin A. An abrupt decrease in vitamin A consumption was shown

with lowered family income, family education, and physical home rating classes. The highest two income classifications (Groups A and B, combined, and Group C) exceeded the Bureau of Home Economics standard of 6000 International Units of vitamin A per unit person daily, whereas the two lower income groups received slightly less than this standard. The results of the photometer tests, discussed in a later section of this report, indicate that the present standard may not be sufficiently high for optimum darkness adaptation response.

When the children were grouped as to cash income and distributed as to five arbitrary levels of vitamin A intake, Figure 3, Sections 21, 22, 23, and 24, show that 3.2 per cent of the children in Income Groups A and B consumed 24,000 International Units of vitamin A per unit person, daily, with 6.4 per cent consuming from 23,999 to 13,000, 58.1 per cent from 12,999 to 8,000, 25.9 per cent from 7,999 to 3,000, and only 6.4 per cent below 3000 International Units. A marked decrease was seen in the percentages of children in the higher vitamin A intake groups, with a corresponding increase in the lower intake groups as income became less.

Vitamin $B_1$. The average intake of vitamin $B_1$ was gradually less with lowered socio-economic status. When the children were grouped as to family cash income, for example, the A and B Income Groups, combined, reached the Bureau of Home Economics standard of 500 International Units of vitamin $B_1$, per unit person, daily, whereas Income Groups C and D averaged somewhat below the standard, and Group E received but 70 per cent of the standard, approximately.

When the children were grouped by family income and distributed as to level of vitamin $B_1$ intake, few in any income group were found to exceed the Bureau of Home Economics standard of 500 International Units per unit person, daily. Figure 3, Sections 25, 26, 27, and 28, show that, in the highest income groups (Groups A and B, combined), for example, only 3.2 per cent of the children consumed 1000 International Units of vitamin $B_1$ or above, with none consuming from 999 to 750 International Units, although larger percentages of the children of some of the lower income groups fell in these two higher groups. It is seen that 48.5 per cent of the children in Income Groups A and B consumed from 749 to 500 International Units of this vitamin, with 41.9 per cent receiving from 499 to 250 units, and only 6.4 per cent less than 250 International Units per unit person, daily.

Vitamin C. In vitamin C intake all socio-economic groups reached or exceeded the Bureau of Home Economics standard of 75 milligrams of ascorbic acid per unit person, daily, except the C group of physical home rating, which was but slightly below the standard. Since measurements of blood plasma ascorbic acid were not made on the children of this study for reasons already given, it is not known whether or not they were receiving adequate quantities of this vitamin, on the average. Recent blood ascorbic acid determinations in the same two communities from which the children for the study were selected indicate that the standard may not be sufficiently high for optimum blood values.

When the children were grouped as to income and distributed as to percentage intake of different levels of vitamin C, a consistent tendency was shown toward greater percentages of children from the higher income groups to be in the higher intake groups, and for greater percentages

from the lower income group to be in the lower intake groups as may be seen in Figure 3, Sections 29, 30, 31, and 32. In the highest income classification (Groups A and B, combined), 22.6 per cent of the children consumed 120 milligrams or more of vitamin C per unit person, daily, while 38.7 per cent consumed from 119 to 90 milligrams, 25.8 per cent from 89 to 60 milligrams, 129 from 59 to 30 and none below 30 milligrams. As mentioned, the percentages in the higher intake groups decreased and those in the lower groups increased as income became lower.

Riboflavin. Since analyses of many foods for riboflavin content have not been made, it is possible that the average intakes of this vitamin reported herein may be low. According to the data as found, the average intake of this nutrient by the children decreased as family income, family education, and physical home rating were lower, with all groups within each of the socio-economic sub-divisions below the present Bureau of Home Economics standards of 1.8 milligrams per unit person, daily.

When the children were grouped according to income and distributed by intake of riboflavin, as shown in Figure 3, Sections 33, 34, 35, and 36, the groups showed a consistent trend toward lower intakes of this vitamin with decreasing incomes. Incomes A and B combined had 3.3 per cent of the children in the arbitrary group of consumption of 1.80 milligrams of riboflavin and above; 30.0 per cent from 1.79 to 1.30 milligrams; 36.7 per cent from 1.29 to 0.80 milligrams, 23.3 per cent from 0.79 to 0.30 milligrams, and 6.7 per cent below 0.30 milligrams of riboflavin per unit person, daily. The lowest income group - Group E - on the other hand had 0.0, 5.4, 10.8, 40.5, and 43.2 per cent of the children in the respective intake groups of this vitamin, with the intermediate income groups showing intermediate decreases in percentages in the higher, and increases in the lower consumption classifications.

Although no standards for the requirements of the different nutrients are generally accepted at the present time, those of the Bureau of Home Economics, United States Department of Agriculture (10), are used most frequently in this country as points of reference. In Table 8 are shown these standards, together with the percentage of children in the various income groups above these standards for the nutrients under consideration.

## RELATIONSHIP BETWEEN DIETARY INTAKE AND NUTRITIONAL STATUS

A knowledge of the inter-relationships between the intake of various nutrients and the responses to nutritional status tests of human beings is one of the major objectives of the long-time study of which the work described in this report was one unit. For purposes of the present study, the following possible relationships have been considered: the percentages of the children, in different groups classified according to nutritional rating by physical examination, which were found in different intake classes for all of the nutrients discussed in this study; the percentages of the children in different groups classified as to skeletal maturity classes, which were found in different intake classes of energy, protein, calcium, phosphorus, and vitamin A; the percentages of the children in different groups classified as to response to the biophotometer bright light factor, which were found in different intake classes of vitamin A; the percentages of the children in different groups classi-

fied as to biophotometer total integration factors, which were found in different intake classes of vitamin A; the percentages of the children in different groups classified as to hemoglobin content of the blood, which were found in different classes of iron and of protein intake. These distributions are shown in Figure 4.

From the data shown in Figure 4, it is apparent that 25.0 per cent of the children having a physical examination rating of 85 points or more consumed 2800 calories of energy or above, 41.6 per cent from 2799 to 2200, 25 per cent from 2199 to 1600, 8.3 per cent from 1599 to 1000, and none below 1000 calories per unit person, daily. In general, the percentages of the groups with high calorie consumption diminished from the higher to the lower intake groups as the physical examination ratings of the children became lower.

No consistent tendencies were seen in the distribution of the children with respect to protein intake classes when they were grouped according to their nutritional rating by physical examination. When the children in the three highest protein intake groups were considered together, however, 83.3 per cent of the children in the highest physical rating group were included in these combined classes, with 78.5, 76.2, 71.3, and 60.0 per cent of those in the succeeding physical examination classes, respectively, in the same combined protein intake classes. On the other hand, 16.7, 15.5, 23.8, and 40.0 per cent of the children in the two lowest protein intake groups, combined, were found in the respective physical rating classes in decending order.

Calcium intake showed no regular tendencies in the upper intake classes when the children were classified as to their physical examination ratings and distributed as to the percentage within each class consuming different amounts of calcium. When the lowest calcium intake was considered, however, only 8.3 per cent of the children in the highest physical examination rating class fell in the lowest calcium intake class, with 16.8, 17.9, 25.0,and 60.0 per cent of the children in the successive remaining physical examination classes, respectively, included therein.

No consistent tendencies with respect to phosphorus intake were observed for the various physical examination rating groups.

A slight tendency was observed for a larger number of children in the higher physical examination rating classes to occur in the highest two iron intake classes, and for a larger number of children in the lower physical examination classes to be found in lower iron intake classes. Thus, 13.0 per cent of the children in the highest physical rating class occurred within the highest two iron intake classes, with 3.5, 3.5, 3.7, and 0.0 per cent of the children in the succeeding physical rating classes coming within the two highest iron intake classes. Beyond these two iron intake classes, however, no regular tendencies were observed.

With respect to vitamin A intake by children of the various physical examination rating classes, the children in the first four classes of physical examination rating had approximately the same percentages in the two highest vitamin A intake classes, with no children from the fifth physical examination rating group in the highest two intake classes. On the other hand, no children from the first four physical examination rating groups were found in the lowest vitamin A intake class, while 20.0 per cent of the children in the fifth physical examination group occurred

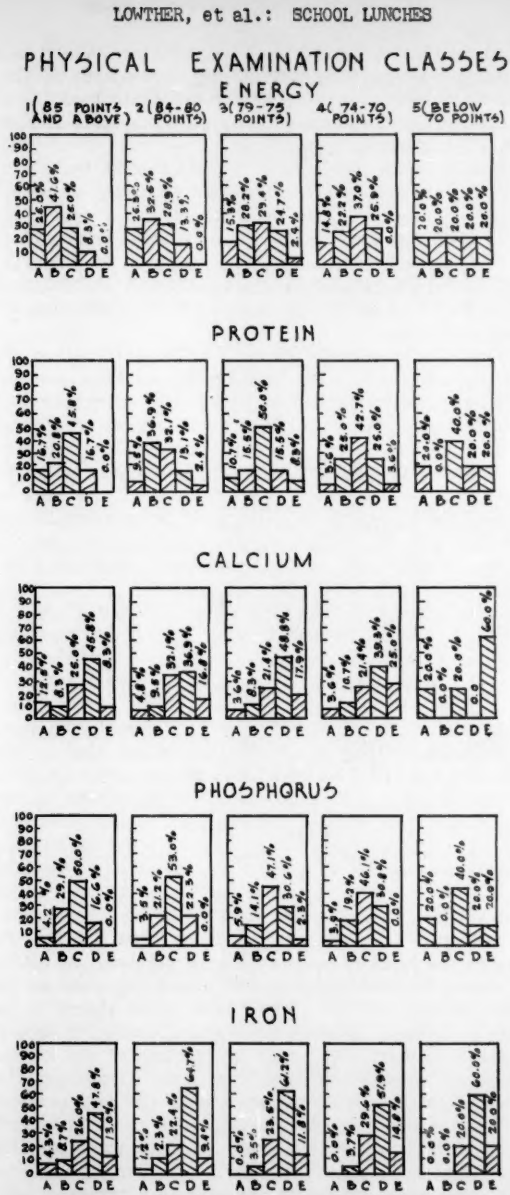



Fig. 4

For description see page 241.

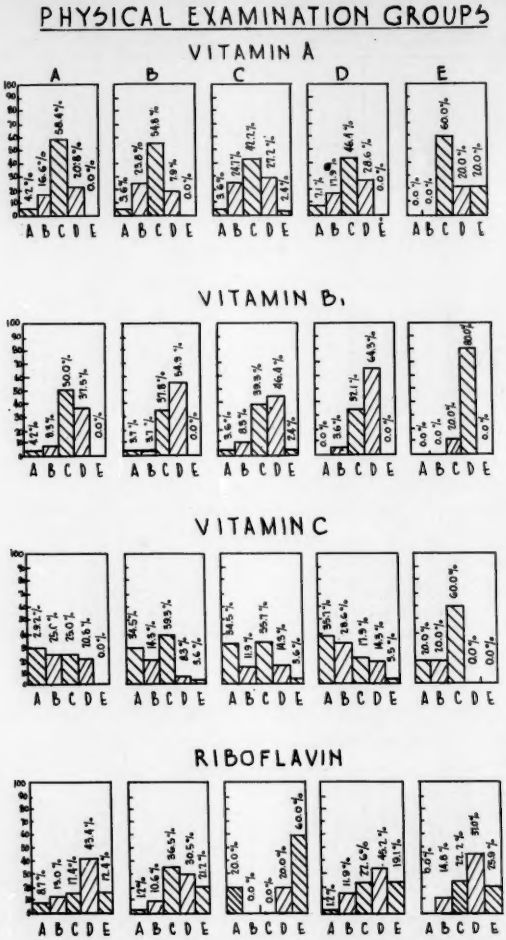



Fig. 4 (Continued)

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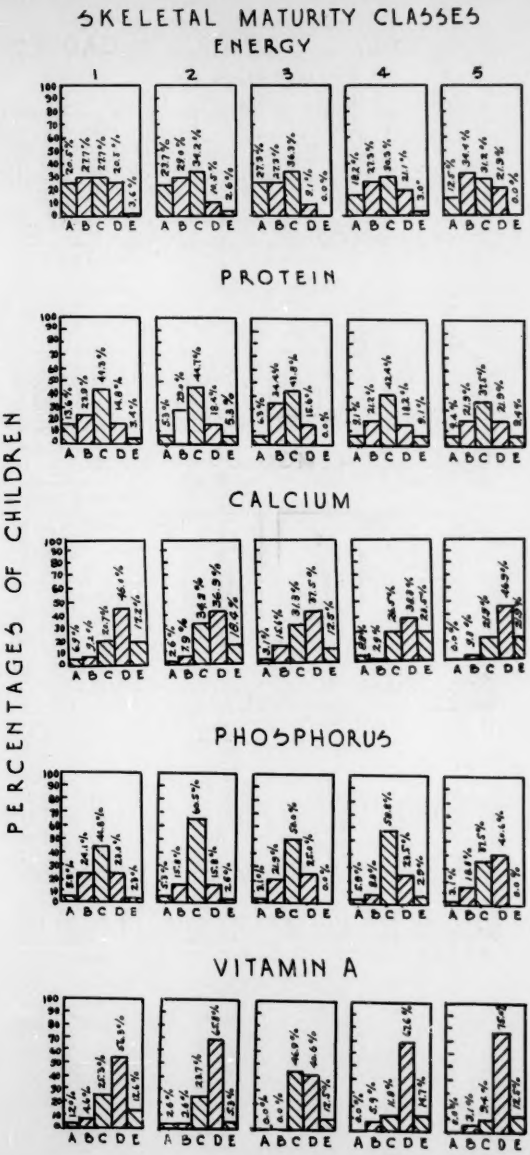


Fig. 4 (Continued)

For description see page 241.

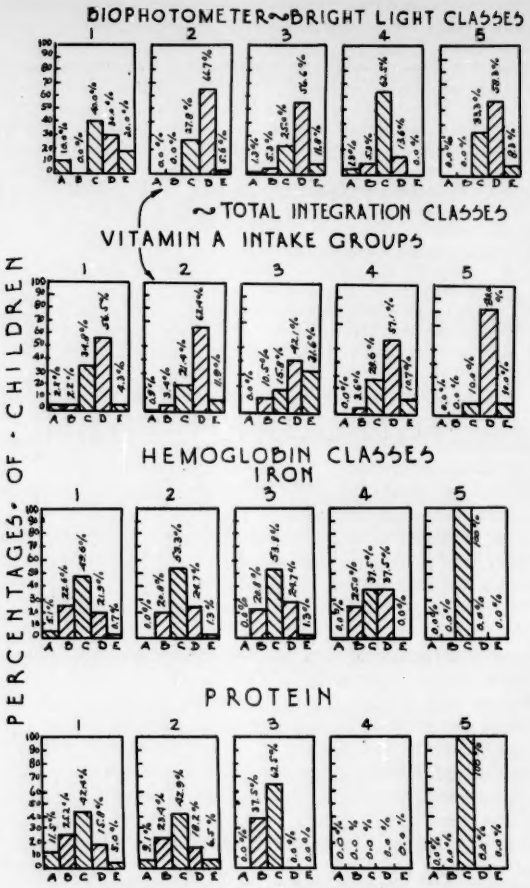


Fig. 4 (Continued)

For description see page 241.

**Fig. 4. Distribution of Children, Grouped as to Nutritional Rating by Physical Examination, as to Percentages within the Different Arbitrary Energy, Protein, Calcium, Phosphorus, and Iron Intake Classifications.**

**Distribution of Children, Grouped as to Nutritional Rating by Physical Examination, as to Percentages within the Arbitrary Vitamin A, Vitamin $B_1$, Vitamin C, and Riboflavin Intake Classifications.**

**Distribution of Children, Grouped as to Skeletal Maturity Classes, as to Percentages within Different Arbitrary Energy, Protein, Calcium, Phosphorus and Vitamin A Intake Classifications.**

**Distribution of Children Grouped as to Biophotometer Bright Light Classes and separately as to Biophotometer Total Integration Classes, on the Basis of Percentages within Different Arbitrary Vitamin A Intake Groups.**

**Distribution of Children Grouped as to Hemoglobin Classes on the Basis of Percentages within Different Arbitrary Iron and Protein Intake Groups.**

in the same vitamin A intake class. Vitamins $B_1$, C, and riboflavin showed a distinct tendency toward larger percentages of the children in the higher physical examination rating groups also in the higher intake classes, with a larger percentage of children in the lower physical examination rating groups also in the lower intake classes.

To summarize, when the children were grouped according to their physical examination rating, the percentages in the higher nutrient intake classes were generally greater in the higher physical examination rating classes and vice versa.

When the children were classified according to their response to the skeletal maturity assay, no relationship was found between level of energy intake and skeletal maturity class.

The three highest skeletal maturity classes had a larger percentage of children in the two highest protein intake groups than was the case with the two lowest maturity classes. On the other hand, the two lowest skeletal maturity classes had a higher percentage of children in the two lowest protein intake groups than in the three highest groups. The same general trend was evident in the distribution of children according to calcium intake within the various classes of skeletal maturity.

No notable differences in phosphorus intake of children in the various skeletal maturity classes were evident except that a considerably lower percentage in the fifth class of skeletal maturity was found in the highest three groups of phosphorus intake, and a considerably higher percentage occurred in the lowest two groups of phosphorus intake, than in the higher skeletal maturity classes.

The percentages of children in the highest three classes of skeletal maturity were distinctly higher in the highest three vitamin A intake classes than in the lowest two classes. The percentages in the lowest two skeletal maturity classes, on the other hand, were markedly greater in the lowest two vitamin A intake classes than in the highest three classes.

When the children were grouped as to their biophotometer bright light factor classes, 50 per cent of the children in the highest bright light class occurred in the highest two vitamin A intake classes, and 50.0 per cent in the lowest three vitamin A intake classes, whereas none of those in the lowest bright light factor class occurred in the highest two vitamin A intake groups. The intermediate bright light response classes showed the same trend, in the main.

When the children were grouped as to their biophotometer total integration factors, the percentage of children in the highest total integration factor class in the highest three vitamin A intake groups, was 39.2 per cent, while that in the lowest test response group was 10.0 per cent in these high intake groups. The reverse was true with respect to the percentage in the lower vitamin A intake groups.

When the children were classified according to hemoglobin status, no definite tendency was shown with respect to iron or protein intakes for those in the different hemoglobin groups.

The comparison of responses to certain of the nutrition tests and intake of various of the nutrients indicates that lowered nutritional rating as measured by these tests was undoubtedly associated with undesirably low intakes of various of the nutrients. The interrelationships are complicated, however, and they await further analysis before they can be more clearly explained. From the evidence in hand, nevertheless, both the responses to the nutrition tests and the analysis of the dietary intakes of the children clearly indicate the need for improvement in nutritional status of a considerable proportion of the children in all socio-economic groups, with this need becoming more acute as the socio-economic level becomes lower.

## PLANNING A MID-DAY MEAL FOR CHILDREN IN VARIOUS INCOME GROUPS

A rational approach to the subject of improving the nutritional status of children of school age would be the feeding of a mid-day meal which would supplement the morning and evening meals which are being fed to the average children in various socio-economic groups. With annual family cash income as a measure of socio-economic status of urban children, Figure 5 has been drawn to show the average daily intake of the children per unit person for breakfast and dinner, combined, for each of the nutrients considered in this report, and the amounts of each of the nutrients needed by each income group, on the average, to meet the Bureau of Standards requirement for that nutrient. In the figure, the average intakes (per unit person, daily) for breakfast and dinner of the respective nutrients are shown at the left of each section of the graph, with the Bureau of Home Economics standard for that nutrient (marked A) shown in the same section. At the right in each section, the needed amount of the nutrient to bring each income group up to the present standard is shown, and is designated as I. L., abbreviated from ideal lunch. In the case of vitamin A, the Bureau of Home Economics standard is given, as in the other cases, and a higher value, 8000 International Units as suggested by Mack and Sanders (7) to be associated with the highest class of response to a photometer test, also is shown (marked $A_X$). The ideal lunch needed to supply each of these quantities is shown, that for the Bureau of Home Economics standard being labeled in the usual manner, and that for supplying 8000 International Units per unit person, daily, being marked I. $L._X$.

In determining what should be the nutrient content of a school lunch offered for sale, the data graphed in Figure 4 indicate the desirability of stressing intake of protein, calcium, phosphorus, iron, and the various vitamins, while minimizing the foods which furnish energy as their

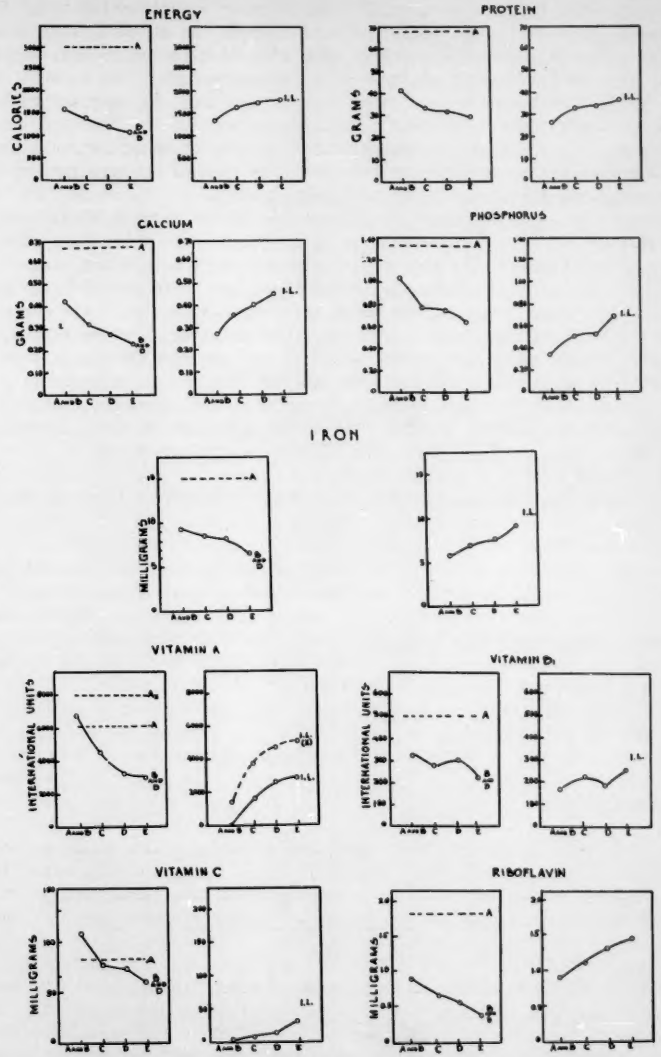


Fig. 5. (Left) Average Intakes of Nutrients During Breakfast and Dinner Combined (B and D), In Comparison with Bureau of Home Economics Standards (A) for the Respective Nutrients, with the Children Classified by Income Groups.

(Right) Average Requirement of an Ideal Lunch (I. L.) which would supplement Breakfast and Dinner, Combined, and bring Them Up to the Standard.

chief contribution. The opposite frequently is done in school organizations in which a limited budget is available for maintaining the school lunch. Careful planning, however, will make it possible to supply the nutrients most likely to be inadequate in the home diets at a small cost.

Where school lunches are to be made available at no cost to the child, either through the use of surplus commodities or otherwise, the question then arises as to what children in the school shall receive the lunch. It is evident from the data presented in this report that need for such a lunch for the purpose of supplementing an otherwise inadequate home diet becomes progressively greater as such factors as family income and family education become lower. Nevertheless, the percentage of children in the higher socio-economic groups meeting the Bureau of Home Economics dietary intake standards is not high, and therefore a school lunch high in protein, minerals, and vitamins at no cost to the child would seem to be a desirable ideal. The percentages of children in this study in each income group meeting the standard for the nine nutrients considered in this report are shown in Table 8.

The two most striking points in connection with the data in this table are the following: first, the percentages of children in the highest income group - A and B, combined - meeting or exceeding the standards for all nutrients except vitamins A and C (in which cases the standards may be too low) are comparatively small; and second, the percentages of children meeting or exceeding the standards generally fall off sharply with family income.

From the ideal point of view, a mid-day meal supplying the nutrients most likely not to be received at home should be provided at school to all children shown by objective nutritional tests to be in need thereof. From practical considerations, however, it will probably not be possible

TABLE 8

PERCENTAGE OF CHILDREN OF DIFFERENT INCOME GROUPS WHO MET OR EXCEEDED THE BUREAU OF HOME ECONOMICS STANDARDS FOR INTAKE OF VARIOUS NUTRIENTS

| Bureau of Home Economics Standard for Nutrient Intake Per Unit Person, Daily | Percentage of Children Meeting or Exceeding Standard in Their Three-Meal Daily Intake. | | | |
|---|---|---|---|---|
| | Income Groups A and B | Income Group C | Income Group D | Income Group E |
| Energy 3000 calories | 35.6% | 9.7% | 5.4% | 0.0% |
| Protein 67 grams | 32.2% | 20.8% | 16.1% | 2.7% |
| Calcium 0.68 grams | 51.6% | 14.9% | 7.1% | 5.4% |
| Phosphorus 1.32 grams | 51.6% | 33.7% | 33.9% | 18.9% |
| Iron 0.0150 grams | 51.6% | 22.6% | 26.7% | 10.8% |
| Vitamin A 6000 International Units | 80.6% | 46.5% | 41.1% | 27.0% |
| Vitamin $B_1$ 500 International Units | 51.7% | 29.7% | 23.3% | 16.2% |
| Vitamin C 75 Milligrams | 93.5% | 72.3% | 67.9% | 56.8% |
| Riboflavin 1.8 milligrams | 16.1% | 3.0% | 3.6% | 2.7% |

for some time to test all of the children in many school systems. The problem then resolves itself into which, if any, children to feed at school for the purpose of improving nutritional status.

If lunches are supplied at nominal cost or without cost to all grade school children, one or the other of the following plans seems worthy of recommendation:

(1) The amounts of each of the nutrients in the ideal lunch for the lowest income group in Figure 5 may be fed to all children, so that the lowest income group and the most poorly nourished children in the other income groups may receive the articles of diet needed for nutritional adequacy. Parents of the children could simultaneously be instructed as to the diets being given at school, and as to recommended dietaries for the morning and evening meal needed to complement the mid-day intakes.

(2) Amounts of the nutrients mid-way between that needed in the ideal lunch for the highest and that for the lowest incomes could be served, with parental instruction given as to the morning and evening requirements.

(3) Only children in the two lowest income groups could be fed, the daily mid-day amounts being that of the lower of the two groups in the case of each nutrient.

In considering either the first or third suggestion, the question arises as to whether or not, in one meal, the quantities of the different nutrients required to supplement the morning and evening meals of the children of the lowest income group would be possible from the practical point of view. Taking the higher amount of each nutrient needed to be added to the average breakfast and dinner intakes for the two lowest income groups, the ideal lunch needed to supply these amounts would contain approximately: 1660 calories of energy, 34 grams of protein, 0.45 grams of calcium, 0.70 grams of phosphorus, 0.082 milligrams of iron, 2592 International Units of vitamin A, 271 International Units of vitamin $B_1$, 22 milligrams of vitamin C, and 1.39 milligrams of riboflavin, per unit person. In order to calculate these values to the basis of children of different ages, the unit person content of a group should be ascertained by assigning to each child, in the group, according to sex and age, the unit equivalent for each of the nutrients, as shown in Table 1 of this report. The sum of these units gives the unit person content of the group with respect to each of the nutrients.

Suppose, for example, a school group is composed of 20 children, including 9 boys and 11 girls. One of the boys is 8, six are between 9 and 10, and two are 11 years of age. Six of the girls are between the ages of 8 and 10, one is 7, and four are from 11 to 12 years of age. Table 9 presents the calculation of the unit person content of the group for each of the nutrients, and the method of ascertaining the approximate quantity of each nutrient required for the ideal lunch to supplement the home diets of children in the two lowest income groups as recommended on the basis of the data presented in this report.

The quantity of nutrients included in a mid-day meal suggested by this study are higher than those recommended for nursery school children by Hann and Stiebeling (3), probably because many of the subjects in the present study come from lower income families than those of the other investigators.

TABLE 9

METHOD OF CALCULATING DESIRABLE NUTRIENT CONTENT OF MID-DAY MEAL FOR CHILDREN FROM FAMILIES ON LOW INCOMES

| Number | Sex | Age | Unit Factors for Various Nutrients | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Energy | Protein | Calcium | Phosphorus | Iron | Vitamin A | Vitamin $B_1$ | Vitamin C | Riboflavin |
| 1 | M | 8 | 0.7 | 1.0 | 1.5 | 0.8 | 0.7 | 0.9 | 0.7 | 0.7 | 0.9 |
| 6 | M | 9-10 | (0.8 x 6) 4.8 | (1.1 x 6) 6.6 | (1.5 x6) 9.0 | (0.9x6) 5.4 | (0.8 x6) 4.8 | (0.9x6) 5.4 | (0.8x6) 4.8 | (0.8x6) 4.8 | (0.9x6) 5.4 |
| 2 | M | 11 | (0.83x2 ) 1.66 | (1.1 x 2) 2.2 | (1.5 x2) 3.0 | (0.9 x2) 1.8 | (0.9 x2) 1.8 | (1.0x2) 2.0 | (0.83x2) 1.66 | (0.9x2) 1.8 | (1.0x2) 2.0 |
| 1 | F | 7 | 0.5 | 0.8 | 1.5 | 0.8 | 0.5 | 0.75 | 0.5 | 0.7 | 0.75 |
| 6 | F | 8-10 | (0.7 x 6) 4.2 | (1.0 x 6) 6.0 | (1.5x6) 9.0 | (0.8x6) 4.8 | (0.7x6) 4.2 | (0.9x6, 5.4 | (0.7x6) 4.2 | (0.7x6) 4.2 | (0.9x6) 5.4 |
| 4 | F | 11-12 | (0.8 x 4) 3.2 | (1.1 x 4) 4.4 | (1.5x4) 6.0 | (0.9x4) 3.6 | (0.8x4) 3.2 | (0.9x4) 3.6 | (0.8x4) 3.2 | (0.8x4) 3.2 | (0.9x4) 3.6 |
| Total for the Group | | | 15.06 | 21.0 | 30.0 | 17.2 | 15.2 | 18.05 | 15.06 | 15.4 | 18.05 |
| average for the Group | | | 0.75 | 1.05 | 1.50 | 0.86 | 0.76 | 0.90 | 0.75 | 0.77 | 0.90 |
| Needed Content per Child for Mid-Day Lunch[1] (Per Unit Person Need X Average Unit Factor) | | | (1660x0.75) 1245 calories | (34x 1.05) 36 grams | (0.45 x 1.5) 0.68 grams | (0.7 x 0.86) 0.60 grams | (0.0082 x 0.75) 0.0062 grams | (2392 x 0.9) 2333 International Units | (271 x 0.75) 203 International Units | (22 x 0.77) 17 Milligrams | (1.39 x 0.9) 1.25 Milligrams |

[1] Calculated on the basis of the needs of the two lowest income groups in order to supplement the average content of the morning and evening meals.

The authors have calculated many dietaries which would serve as practical lunches supplying approximately the quantity of the nutrients per unit person, daily, which would be needed on the average for the two lowest income groups as shown by the data of this report, and exemplified in Table 9. The diets included a wide variety of foods, so that there would be no need for monotony. Foods which frequently constitute surplus commodities were found to fit well into a planned mid-day meal intended to be high in proteins, minerals, and vitamins, the need for which was indicated by these findings. In many cases, the menus which supplied desirable amounts of energy, protein, calcium, phosphorus, and iron were higher in certain of the vitamins, particularly vitamin A and vitamin C than is called for to supplement the home morning and evening meals of the low income group of children in question according to the standards used. It was not deemed undesirable by the authors to allow these factors to be higher than is indicated in Table 9, however, because it is believed that the present standards for these factors may be found to be too low.

It is planned by the authors to continue the study and to measure these or similarly selected children for nutritional status periodically while supplying the type of mid-day meal suggested in this report.

## SUMMARY

Two hundred and twenty-five children were selected from two urban communities to find from dietary records and nutritional status measurements what should constitute a satisfactory noon-day meal to supplement the morning and evening diets of children of different socio-economic groups. Details are presented concerning the diets of the children and their responses to the various nutritional status tests, and recommendations concerning the nutrient content of a school lunch are made.

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